Printed on Thin Paper for Foreign Circulation.

MAY 2 1923

The Engineer.

Established 1856. Registered as a Newspaper.

OFFICE FOR ADVERTISEMENTS & PUBLICATION, 33, NORFOLK ST., STRAND, LONDON, W.C. 2.

Vol. CXXXV.—No. 3512] LONDON: FRIDAY EVENING, APRIL 20, 1923 [PRICE ONE SHILLING BY INLAND POST 1s. 3d.

The Engineer

PRINCIPAL CONTENTS OF THIS ISSUE.

British Engineering and the Chinese Market.

The Lakeside Electric Power Station at Milwaukee—No. II.

Steam Nozzle Research.

Crossing the Sahara by Motor Car.

The Corrosion of Metals.

Equivalent Loads on Bridges.

New Sewage Pumping Plant at Bognor.

A Double-headed Scarf-Milling Machine

PUBLIC NOTICES

The Director-General, India Store Department, Branch No. 15, Belvedere-road, Lambeth, S.E. 1, REQUIRES—
MATERIALS FOR VACUUM BRAKE GEAR.
Tenders due 2 p.m. on 4th May, 1923.
Tender forms obtainable from above. 2212

Ministry of Transport. APPLICATIONS are INVITED for TWO APPOINTMENTS as ASSISTANT ENGINEERS in the Roads Department of the Ministry of Transport on the scale £200-20-500 plus bonus. Assistant Engineers are eligible for promotion to the class of Engineering Inspectors on the scale £400-25-800 plus bonus.

Successful candidates will be appointed at commencing salaries of £200. The current Civil Service bonus will be paid in addition, giving at present a commencing salary of £213 4s. per annum. The bonus is subject to revision according to the cost of living index figure.

The appointments will be permanent and pensionable, and selected candidates will be required to serve a two years' probationary period.

Candidates should be corporate members of the Institution of Civil Engineers or should hold some equivalent professional qualification. Experience of road and bridge construction is essential and actual municipal experience is an advantage. Candidates should be not more than 35 years of age and should have served in His Majesty's Forces.

Forms of application can be obtained from the ESTABLISHMENT OFFICER, Ministry of Transport, 6, Whitehall-gardens, S.W.1. Applications can only be received on the recognised forms and should reach the Ministry of Transport on or before the 30th April. 2264

In the High Court of Justice, Chancery Division. 1923 G. 910.
Mr. Justice Astbury.
In the Matter of GEORGE CLARK Limited and
In the Matter of The COMPANIES (CONSOLIDATION) ACT, 1908.

Notice is Hereby Given that the Order of the High Court of Justice Chancery Division dated the 23rd March 1923 CONFIRMING the REDUCTION of the CAPITAL of the above-named Company from £300,000 to £100,000 and the Minute approved by the Court showing with respect to the Capital of the Company as altered the several particulars required by the above Statute was registered by the Registrar of Companies on the 10th day of April 1923.

The said Minute is in the words and figures following:—

"The Capital of George Clark Limited and Reduced is henceforth £100,000 divided into 100,000 shares of £1 each instead of £300,000 divided into 300,000 shares of £1 each. At the time of the registration of this Minute 97,000 shares of £1 each numbered 1 to 97,000 inclusive have been issued and are fully paid up and the remaining 9000 shares of £1 each are unissued."

Dated the 13th day of April 1923.

MANN, LONGDEN and MANN,
Somerford Buildings, Sunderland,
P1272 Solicitors for the Company.

Crystal Palace School of PRACTICAL ENGINEERING.
Founded 1872.
PRINCIPAL—J. W. WILSON, M.I.C.E., M.I. Mech. E.
The NEW COURSE will COMMENCE on MAY 2nd. New Students enter on the morning of May 1st. 2218

Burnham-on-Crouch Urban District Council.
TO WELL SINKERS.
Competent Well Sinkers desiring to TENDER for SINKING a BOREHOLE and TESTING the QUANTITY of WATER to be obtained therefrom are invited to make application for copy of plans, specification and form of Tender to the undersigned not later than the 25th April, 1923.

A deposit of £1, to accompany the application, which will be returned upon receipt of a bona fide Tender and the return of the plans.

Sealed Tenders, endorsed "Tender for Borehole," to be delivered to me not later than 2 p.m. on Tuesday, the 15th May, 1923.

E. DILLIWAY,
Clerk to the Council.
Council Offices,
Burnham-on-Crouch.
16th April, 1923. 2216

Clyde Navigation.
TO SHIPBUILDERS.
GRAB HOPPER DREDGER.
The Trustees of the Clyde Navigation invite TENDERS for a GRAB HOPPER DREDGER, 186ft. long overall, 35ft. breadth moulded, and 16ft. depth moulded.

The specification and form of Tender, along with drawings, may be obtained on application at this office to Mr. Daniel Fife, Mechanical Engineer, on payment of a fee of £3 3s., which will not be returned.

Sealed Tenders, marked "Tender for Grab Hopper Dredger," require to be lodged with the undersigned not later than Noon on Monday, 21st May.

The Trustees may not accept the lowest or any Tender.

T. R. MACKENZIE,
General Manager and Secretary.
16, Robertson-street, Glasgow,
13th April, 1923. 2197

Richmond Main Sewerage Board.
CONTRACTS FOR STORES.
The Board are prepared to receive TENDERS for the SUPPLY and DELIVERY to their Works during the Year ending May 31st, 1924, of the following STORES:—

STEAM COAL (Welsh).
GREY LIME.
BUXTON LIME.
SEWAGE PRECIPITANTS.
FILTER PRESS CLOTH.

Specifications may be inspected and further particulars obtained on personal application only at the office of Mr. William Fairley, M. Inst. C.E., Engineer to the Board, West Hall-road, Kew Gardens, Surrey.

Sealed Tenders, on the forms provided, to be delivered to the undersigned on or before Tuesday, May 8th, 1923.

The Board do not bind themselves to accept the lowest or any Tender.

J. LESLIE G. POWELL,
Clerk to the Board.
The Sessions House,
Richmond, Surrey,
11th April, 1923. 2190

PUBLIC NOTICES

Administrative County of LONDON.
ABBEY MILLS PUMPING STATION ENLARGEMENT, 1923.
The London County Council invites TENDERS for the CONSTRUCTION of FOUNDATIONS for a new installation of Engines and Pumps, BOILER FOUNDATIONS and ECONOMISER HOUSE and the CONSTRUCTION of a NEW PUMPING MAIN between the Engine-house and the Northern Outfall Sewers, and other works in connection therewith, at the Council's Abbey Mills Pumping Station, in the Borough of West Ham, in the County of Essex.

Persons desiring to Tender may obtain the form of Tender, &c., on application to the Chief Engineer at the Old County Hall, Spring-gardens, S.W.1, upon payment of the sum of £5. This amount will be returnable only if the tenderer shall have sent in a bona fide Tender and shall not have withdrawn the same. Full particulars of the work may be obtained on personal application, and the contract document may be inspected before the payment of the fee.

No Tender received by the Clerk of the Council at the County Hall, Westminster Bridge, S.E.1, after Twelve Noon on Tuesday, 15th May, 1923, will be considered.

The Council does not bind itself to accept the lowest or any Tender.

JAMES BIRD,
2235 Clerk of the London County Council.

City of Bradford.
ELECTRICITY DEPARTMENT.
The Electricity Committee of the Bradford Corporation invite TENDERS for the PURCHASE and REMOVAL of ONE CROSS-COMPOUND CORLISS VERTICAL TOTALLY ENCLOSED ENGINE (by Musgrave, Bolton), coupled to a 1000 Kilowatt WESTINGHOUSE D.C. GENERATOR, together with CONDENSER, STEAM and OIL SEPARATORS, AIR PUMPS, BARRING ENGINE, certain PIPING, &c., and of ONE 380-Kilowatt WILLANS-E.C.C. D.C. GENERATING SET (without Condensing Plant or Piping), installed at the Electricity Generating Station, Valley-road, Bradford.

Form of Tender and abridged specification of the plant may be had on application to the City Electrical Engineer and Manager, 45 to 49, Sunbridge-road, Bradford, to whom all inquiries respecting the plant should be addressed. The plant, which is in good running order, may be inspected any day, Monday to Friday inclusive, between the hours of 10 a.m. and 5 p.m., and on Saturday from 10 a.m. to 12 noon, and, if desired the 1000 K.W. Set, but not the 380 K.W. Set, can be run on load on application being made.

Sealed Tenders, endorsed "Tender for Generating Sets," to be sent to me not later than 10 a.m. on Friday, 11th May, 1923.

N. L. FLEMING, Town Clerk.
Town Hall, Bradford, 17th April, 1923. 2223

South Staffordshire Waterworks COMPANY.
SANDFIELDS PUMPING STATION, LICHFIELD.
TENDERS FOR DISMANTLING PLANT.
CONTRACT NO. 3.
The Chairman and Directors are prepared to receive TENDERS for the PURCHASE, DISMANTLING and REMOVAL of THREE FLY-WHEEL BEAM ENGINES and TWO LANCASHIRE BOILERS at their Sandfields Pumping Station, Lichfield.

Copies of conditions of contract, specification and form of Tender, with permit to visit station, may be obtained from the undersigned.

Sealed Tenders, addressed to me and endorsed "Tender for Dismantling Plant, Lichfield," must be delivered not later than 10 a.m., Monday, the 7th of May, 1923.

The Chairman and Directors do not bind themselves to accept the highest or any Tender.

FRED. J. DIXON, M. Inst. C.E.,
Engineer.
Engineer's Office,
26a, Paradise-street, Birmingham,
17th April, 1923. 2221

PUBLIC NOTICES

East Indian Railway. The Directors are prepared to receive up to Eleven o'clock a.m. TENDERS for the SUPPLY of:—
(1) COPPER FIRE-BOX PLATES AND RODS.
(2) FILES.
(3) PICKS, PHOWRAHS AND SHOVELS.
(4) ROLLED MATERIAL FOR CONSTRUCTION OF BOILERS.
(5) LOCOMOTIVE BOILERS, &c.,
for Nos. 1, 2, 3 and 4 on Wednesday, the 2nd May proxime, and for No. 5 on Wednesday, the 9th May proximo.

Copies of the specifications can be obtained at the Company's offices on payment of £1 1s. each. This fee will not be returned.

G. B. LILLIE,
Secretary.
73-76, King William-street, London, E.C. 4,
10th April, 1923. 2240

9/3/23.

State Electricity Commission of VICTORIA, AUSTRALIA.
TENDERS are INVITED for the MANUFACTURE, SUPPLY, DELIVERY, and SUPERINTENDENCE of ERECTION of the following:—
SPECIFICATION No. 23/63.—ELECTRICALLY OPERATED POWER SHOVEL.
Tender forms, specification, contract conditions, &c., are available upon application to—
Agent-General for Victoria,
Melbourne-place, Strand,
London, W.C.

The charge per one set of two copies of the specification is £1, which will be refunded on receipt of a bona fide Tender and the return of all documents supplied.

Tenders, on prescribed forms, accompanied by a deposit of £50 and endorsed "Specification 23/63.—Electrically Operated Power Shovel," will be received up to Noon on the 31st July, 1923, by

R. LIDDELOW,
Secretary,
State Electricity Commission of Victoria,
22-32, William-street, Melbourne.

The Commission does not bind itself to accept the lowest or any Tender. 2206

Department of Public Works,
Sydney, 31st January, 1923.
SYDNEY HARBOUR BRIDGE TENDERS—
EXTENSION OF TIME.

Tenders are Invited by the Government of New South Wales for the CONSTRUCTION of the SUPERSTRUCTURE and SUBSTRUCTURE of a CANTILEVER BRIDGE across Sydney Harbour from Dawes Point to Milson's Point, embracing a main span of 1650ft. in the clear, centre to centre of main piers, and a length of main bridge 2600ft. centre to centre of anchor piers. The total length of main bridge and approach spans included in Tender is 3610ft.; also an ALTERNATIVE TENDER for the CONSTRUCTION of the SUPERSTRUCTURE and SUBSTRUCTURE of an ARCH BRIDGE across Sydney Harbour from Dawes Point to Milson's Point, embracing a main span of 1650ft. in the clear, centre to centre of bearings. The total length of main bridge and approach spans included in Tender is 3770ft. Either bridge is to provide for four lines of railway, six lines of vehicular traffic, and footway accommodation.

Copies of specification, including plans, technical information, general conditions, and Tender forms, may be obtained by bona fide tenderers on application to the Under-Secretary for Public Works, Sydney, or to the Agent-General for New South Wales, Australia House, The Strand, London; the Minister of Railways and Canals, Ottawa; the Australian Trade Commissioner in the United States, New York; or the Bureau of Foreign and Domestic Commerce, Washington, D.C., United States.

Tenders, the time for which has been extended, must reach the Under-Secretary for Public Works, Sydney, New South Wales, not later than 30th November, 1923.

R. T. BALL,
2085 Minister for Public Works and Railways.

PUBLIC NOTICES

East Stow Rural District COUNCIL.
COMBS FORD DRAINAGE.
CONTRACT NO. 2.
The Council are prepared to receive TENDERS for the CONSTRUCTION of about 220 YARDS of STONEWARE PATENT JOINTED SEWERS of 9in. in diameter, with necessary MANHOLES; and also the CONSTRUCTION of a PUMPING STATION, PUMP SUMP and RISING MAIN and other Works in accordance with plans and specifications prepared by Messrs. John Taylor and Sons, Civil Engineers.

Copies of the specification and bill of quantities with form of Tender may be obtained from the office of the Engineers, 36, Victoria-street, Westminster, S.W.1, on payment of £5 (cheque only), which will be returned on receipt of a bona fide Tender.

Drawings may be inspected either at the office of the Engineers or at the office of the Surveyor to the Council at Stowmarket.

Tenders, endorsed "Combs Ford Drainage," are to be delivered on or before Wednesday, 9th May, 1923, addressed to the Clerk to the Council.

The Council do not bind themselves to accept the lowest or any Tender.

(By Order),
HENRY E. WILKES,
Clerk to the Council.
Stowmarket, Suffolk. 2214

Epsom Rural District Council.
The above-named Council invites TENDERS for the SUPPLY of a PORTABLE TAR-MACADAM and BITUMINOUS ASPHALTE PLANT capable of an output of 40 tons of tar-macadam per day of eight working hours.

Full particulars, including operating costs per ton and estimate of probable cost of replacements and renewals, to be sent to Mr. T. E. Ware, the Surveyor to the Council, and sealed Tenders, addressed to the Chairman of the Council, Cyrenside, Waterloo-road, Epsom, to be delivered on or before the 7th day of May next.

The Council does not bind itself to accept the lowest or any Tender.

A. B. COTTON,
Clerk, Rural District Council.
14, Waterloo-road, Epsom,
14th April, 1923. 2210

Metropolitan Water Board.
SUPPLY of 24in. LAP-WELDED STEEL TUBES—VINE-STREET TO TOWER-HILL SUBWAY.
The Metropolitan Water Board invite TENDERS for the SUPPLY of approximately 1400 YARDS of 24in. LAP-WELDED STEEL TUBES [illegible] SPECIALS. The place of delivery is New River Head, Clerkenwell, E.C., or other convenient site, the order of delivery being a period of eight weeks from the Engineer's order to commence work. The making of the field joints to be done in situ.

Forms of Tender, conditions of contract, &c., may be obtained on personal application at the offices of the Board (Room 155), New River Head, 173, Rosebery-avenue, E.C.1, or will be forwarded on receipt of a stamped addressed brief envelope. Tenders, enclosed in sealed envelopes, addressed to "The Clerk of the Board, Metropolitan Water Board, 173, Rosebery-avenue, E.C.1," and endorsed "Tender for Steel Tubes," must be delivered at the offices of the Board not later than 11 a.m. on 4th May, 1923. The Board do not bind themselves to accept the lowest or any Tender.

G. F. STRINGER,
Clerk of the Board.
New River Head,
173, Rosebery-avenue, E.C.1.
17th April, 1923. 2230

The South Indian Railway Company, Limited, are prepared to receive TENDERS for the SUPPLY of:—
1. MISCELLANEOUS ARTICLES.
2. FLARE LIGHTS.
3. FOUNDRY COKE.
4. LEATHER BELTING, &c.

Specifications and forms of Tender will be available at the Company's Offices, 91, Petty France, Westminster, S.W.1.

Tenders, addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked "Tenders for Miscellaneous Articles," or as the case may be, must be left with the undersigned not later than Twelve Noon on Friday, the 4th May, 1923.

The Directors do not bind themselves to accept the lowest or any Tender.

A charge, which will not be returned, will be made of 2s. 6d. for each copy of Specifications Nos. 1 and 2, and of 10s. for each copy of Specification No. 3.

Copies of the drawings may be obtained at the offices of Messrs. Robert White and Partners, Consulting Engineers to the Company, 3, Victoria-street, Westminster, S.W.1.

A. MUIRHEAD,
Managing Director.
91, Petty France, S.W.1,
17th April, 1923. 2232

PUBLIC NOTICES (continued) Page 2.

SITUATIONS OPEN, Page 2.
SITUATIONS WANTED, Page 2.
PARTNERSHIPS, Page 2.
PATENTS, Page 3.
MACHINERY, &c., WANTED, Page 3.
FOR SALE, Pages 3, 4, 8, and 93.
AUCTIONS, Pages 8 and 96.
PREMISES TO LET OR WANTED Page 8.
WORK WANTED, Page 93.
AGENCIES, Page 3.
MISCELLANEOUS, Page 2.

For Advertisement Rates See Page 423, Col. 1.

NUMERICAL INDEX TO ADVERTISEMENTS, Page 95.

PUBLIC NOTICES

The Urban District Council of WOMBWELL.

The Rural District Council of ROTHERHAM.

BRAMPTON-ROAD IMPROVEMENT. CONSTRUCTION CONTRACT.

The Councils invite TENDERS for the RAISING, WIDENING and IMPROVEMENT of BRAMPTON-ROAD, including the DEMOLITION of existing STRUCTURES, the PROVISION and ERECTION of NEW STEEL GIRDER BRIDGES on BRICK PIERS and ABUTMENTS, the EXECUTION of RETAINING WALLS, BUILDING of EMBANKMENTS, FORMATION of CUTTINGS, FENCING, CONSTRUCTION of CARRIAGE-WAYS and FOOTPATHS, PROVISION of SURFACE WATER DRAINAGE, and all other contingent Works.

Complete Tenders must be submitted, covering the whole of the works. Tenders for the supply of materials only, or for any separate portion of the works, will not be considered.

Copies of the general conditions, specifications, schedules of quantities and form of Tender may be obtained from either of the undersigned on and after Wednesday, 25th April, 1923, on deposit of £2 2s., which will be returned upon receipt of a bona fide Tender. Duplicate copies may be obtained at the rate of £1 1s. per copy, which amount will not be returned.

The contract drawings may be inspected at the offices of the Engineer, Mr. Arthur R. Hoare, M. Inst. C.E. (Messrs. Stephen Sellon and Partners), 36, Victoria-street, Westminster, London, S.W., on and after the above date, and from whom duplicates of the drawings may be obtained upon payment of the cost of reproduction. Copies of the drawings will also be deposited at the offices of the undersigned and may be inspected during office hours.

Sealed Tenders, on the prescribed form, addressed to the Clerk to the Urban District Council, Town Hall, Wombwell, and endorsed "Tender for Brampton-road Improvement," must be delivered not later than Tuesday, 15th May, 1923.

The Councils do not bind themselves to accept the lowest or any Tender.

F. M. WALKER,
Town Hall, Wombwell,
Clerk to the Urban District Council of Wombwell.

OXLEY and COWARD,
6, Westgate, Rotherham,
Clerks to the Rural District Council of Rotherham.

16th April, 1923. 2240

Ware Urban District Council.

TENDERS are INVITED for the PURCHASE from the above Council of :—

(1) ONE CROSSLEY IMPROVED OPEN-HEARTH SUCTION GAS PLANT, now fixed and at present used with 42 H.P. Gas Engine at the Council's Waterworks Pumping Station, Musley-lane, Ware. Age of plant one year. Tenders are to include for dismantling and removing and making good after the removal.

(2) THREE WROUGHT IRON TANKS, 7ft. 10in. high by 2ft. 9½in. in diameter, which have been used as cooling tanks to a gas engine and are now lying at the above Pumping Station.

The above can be inspected on application to the Council's Surveyor at the Priory, Ware.

Sealed Tenders, endorsed "Waterworks Plant," are to be sent to me on or before Tuesday, the 1st May next. The Council will not be bound to accept any Tender.

Dated the 14th day of April, 1923.

By Order,
GEO. H. GIBBY,
Clerk to the Council.

2196

NOTICE.

Alexandria Municipality.

APPOINTMENT OF ASSISTANT ENGINEER-CHIEF OF ROADS SECTION.

The Municipality invites APPLICATIONS for a VACANT POST of ASSISTANT ENGINEER of ROADS SECTION.

Applications must reach the Municipality by the 20th June, 1923, and must be sent in a double envelope, the outer one addressed to the "Director-General, Alexandria Municipality, Alexandria, Egypt," and the inner one inscribed "Application for the Post of Assistant Engineer, Chief of Roads Section."

The appointment is guaranteed for 4 years, with the option for the Municipality of renewal for further periods of 2 years at a time.

The salary is fixed at £E600 per annum, with increases of £E 60 per annum every two years in case of satisfaction, up to a maximum of £E780.

Minimum age 30.

Applicants must attach to their applications :—

(a) Birth certificate or other document in lieu of it ;

(b) Certificate of good conduct ;

(c) Diploma of Civil Engineer of a recognised school ;

(d) Certificates or other documents testifying that they have regularly attended the course of the school of which they possess the diploma, and that they have had a practical experience as engineer for at least 3 years.

Candidates must be specialists in urban road construction and upkeep and be well posted in up-to-date methods.

A knowledge of English or French is indispensable.

(S.) H. HOPKINSON,
Director-General.

Alexandria, the 29th March, 1923.

P.S.—According to the regulations in force for appointments on the municipal staff the candidate chosen will not be definitely appointed until he is examined by the Medical Commission and found in good health with a normal eyesight.

Applicants from abroad must enclose a medical certificate duly legalised by a competent authority and also a photograph. 2183

SITUATIONS OPEN

WANTED, an Experienced ENGINEER as ASSISTANT to the Chief of a large Testing Department for the responsible testing at makers' works of steam turbines driving alternators and continuous-current dynamos from 200 to 6000 H.P.—Address, stating age, experience, and salary required, 2194, The Engineer Office. 2194 A

WANTED by an Engineering Firm Specialising in Brewery Work, Conveyors, Elevators, Lifts, Electrical and Power Transmission, also Coppersmithing, Metal Plate and Constructional Work, a capable MAN in ESTIMATING DEPARTMENT, essentially a good draughtsman and used to abstracting and framing up detailed specification of schemes, and general correspondence a salient feature. State age, experience, references, and wage expected. No one need apply if not qualified.—Address, 2223, The Engineer Office. 2223 A

MACHINE TOOLS.—WANTED by Well-known and Old-established Firm of Toolmakers and Merchant Engineers, for their London office, a capable well-educated MAN, of good address (30 to 40 years), as REPRESENTATIVE.

Must have good connection amongst the engineers and export houses.

Reply, stating experience and salary required, to "TOOLMAKER," William Porteous and Co., Advertising Agents, Glasgow. P7307 A

MANUFACTURING ENGINEERING COMPANY REQUIRE REPRESENTATIVE in London district. Must have established business, good connection, and be of good address, able to introduce business ; Steam Engines, Sawing Machinery, and General Engineering Work.—Address, 2105, The Engineer Office. 2105 A

METALLURGICAL CHEMIST.—A Thoroughly competent MAN is REQUIRED with the necessary knowledge and experience to control the Chemical and Physical Laboratory and Heat Treatment Department of an important Motor Car Works near London. All replies to state experience in full, giving age and salary required.—Address, 2193, The Engineer Office. 2193 A

SITUATIONS OPEN (continued)

REQUIRED for India, Expert ELECTRICAL ENGINEER, age about 30 and single.—Reply fully, stating age, experience, and salary required, to Z. B. 491, care Deacon's, Leadenhall-street, London. 2237 A

SUB-AGENT and ASSISTANT ENGINEER WANTED for the Tropics. Must be energetic and experienced in public works, about 25 to 40 years of age.—Apply, giving full particulars of experience, to Box 80, c/o Dawson's, 17, Craven-street, Strand, W.C. 2. 2233 A

WANTED, a Good HEATING and VENTILATING DRAUGHTSMAN by a London Firm of Heating Contractors. State age, experience, and salary required.—Address, P7274, The Engineer Office. P7274 A

WANTED, DRAUGHTSMAN for Steam Turbine Work, well up with details and plant lay-outs.—Write, giving age, experience, and salary required, to Messrs. FRASER and CHALMERS, Engineering Works, Erith, Kent. 2249 A

WANTED.—DRAUGHTSMAN, with Good Experience in Mining and Milling Work, WANTED IMMEDIATELY.—Write, giving age, experience, and salary required, to Messrs. FRASER and CHALMERS, Engineering Works, Erith, Kent. 2250 A

WANTED, First-class DRAUGHTSMAN, Thoroughly conversant with Machine-cut Gearing and its application.—Apply, stating age, full experience, and salary required. Only competent men need apply.—DAVID BROWN and SONS (Huddfd.), Ltd., Park Gear Works, Lockwood, Huddersfield. 2245 A

WANTED IMMEDIATELY, Competent DRAUGHTSMAN, accustomed to General Engineering Work. Wages £4 10s. per week.—Apply, stating age and experience, POWELL, DUFFRYN STEAM COAL CO., Barnsley. 2238 A

APPLICATIONS are INVITED by Manchester Engineering Firm for the POSITION of DRAUGHTSMAN with good general engineering knowledge and experience and familiar with Steam Plant, Pipe Work Lay-out and Details. Age 24/40. Electrical experience an advantage. State age, experience, and salary required.—Address, 2222, The Engineer Office. 2222 A

CHIEF DRAUGHTSMAN WANTED, to Take Charge of Large Drawing-office dealing with heavy Mechanical Engineering ; must be capable organiser and thoroughly sound engineer. Good salary and prospects for first-class man.—Write, stating age and full particulars of experience and salary required, Box 1603, Sells' Advertising Offices, Fleet-street, E.C. 4. 2231 A

DRAUGHTSMAN, First-class, REQUIRED AT ONCE. Must have had good Aircraft experience.—Address, stating full particulars, age, salary required, &c., 2181, The Engineer Office. 2181 A

DRAUGHTSMAN for Abroad, with Experience of Reinforced Concrete and Dock Work. Good salary for right man ; three years' agreement.—Address, giving full experience, age, 2224, The Engineer Office. 2224 A

DRAUGHTSMAN REQUIRED, Experienced in Rotary Printing Press Work.—Write full particulars, R. HOE and CO., Ltd., 109, Borough-road, London. 2220 A

DRAUGHTSMAN WANTED, Thoroughly Experienced in the Design of Colliery Electric Winding Engines and Haulage Gears (mechanical portions). —Write, stating age, experience, and salary required, Box 1578, Sell's Advertising Offices, Fleet-street, E.C. 4. 2232 A

DUST REMOVAL.—Westminster ENGINEERING FIRM REQUIRES LEADING DRAUGHTSMAN with extensive theoretical and practical knowledge of Ventilating, Heating, and Dust Removal Plants. Must be able to design and estimate complete installations. State fully training, experience, age, salary required, &c.—Address, 2251, The Engineer Office. 2251 A

EXPERIENCED DRAUGHTSMAN REQUIRED, accustomed to Designing and Detailing all kinds of Electric Cranes. Permanent and progressive position to competent man.—Apply, stating age, experience, and salary, to THOMAS SMITH and SONS (Rodley), Ltd., Steam and Electric Crane Works, Rodley, Nr. Leeds. 2245 A

FIRST-CLASS DRAUGHTSMAN REQUIRED, Thoroughly experienced in all types of Crane Design. No others need apply.—Apply, stating full particulars and salary, JOSEPH BOOTH and BROS., Ltd., Rodley, Leeds. 2163 A

MACHINE TOOL DRAUGHTSMAN REQUIRED for Special Tools, Jigs and Fixtures. Applications are only invited from men of first-class ability. Please state experience and salary expected.—Address, 2178, The Engineer Office. 2178 A

MECHANICAL DRAUGHTSMAN WANTED, with some knowledge in Structural Work.—Address, stating age, experience, and salary required, P7295, The Engineer Office. P7295 A

REQUIRED IMMEDIATELY (a) INSTRUMENT DRAUGHTSMEN with experience in highest-class Camera Work and good workshop and technical training ; (b) SENIOR DRAUGHTSMEN with at least six years' experience in Telephone, Telegraph or Wireless Work ; (c) JUNIOR DRAUGHTSMEN with not less than three years' Drawing-office experience in Telephone, Telegraph or Wireless work. Preference will be given to ex-Service men.—Write, giving full particulars of age, training, experience, and salary required, to SECRETARY (S.2), Air Ministry, Adastral House, Kingsway, W.C. 2. 2134 A

SEVERAL Experienced DRAUGHTSMEN WANTED. Must be capable of Land Engine Design.—Apply, stating full particulars of experience and salary expected, to JAMES CARMICHAEL and CO., Ltd., Ward Foundry, Dundee. P7319 A

SMART DRAUGHTSMAN REQUIRED for Turbo-alternators up to 5000 K.W. ; Manchester district. State age, experience, and salary required.—Address, 2195, The Engineer Office. 2195 A

SITUATIONS WANTED

ADVERTISER, Qualified Mechanical Engineer-draughtsman (24), WANTS POST as Assistant Works Manager or Engineer ; 10 years' experience in steam, electrical, and I.C. plant ; held similar appointments at home and abroad ; lately engaged on asphalt manufacture ; salary £450 to start ; good refs., war service in R.E.s.—Address, P7183, The Engineer Office. P7183 B

ADVERTISER, Married (31), REQUIRES SIT. as experienced Engineers' Clerk, confidential or otherwise. Thorough draughtsman, 5 years D.O., 3 years shops, shorthand (typist ; can handle correspondence, good supervisor ; not afraid of hard work. —Address, P7288, The Engineer Office. P7288 B

ADVERTISER SEEKS APPOINTMENT where experience of light constructional work, overhead runways, estimating, would be an advantage ; also used to following up enquiries, interviewing customers, measuring up, &c. Patentee of flexible and portable ground runways.—Address, 2248, The Engineer Office. 2248 B

CIVIL ENGINEER, Located London, 30 Years' active experience on public works, including 9 in U.S.A., embracing surveys, reports, designs and in charge of construction, DESIRES TECHNICAL APPOINTMENT with financial corporation or would Represent Non-resident Americans having British interests.—Address, P7244, The Engineer Office. P7244 B

SITUATIONS WANTED (continued)

COMMERCIAL ENGINEER DESIRES TO GET in TOUCH with FIRM wanting to DEVELOP TRADE in the East.—Address, P7271, The Engineer Office. P7271 B

CONSTRUCTIONAL and MAINTENANCE ENGINEER (34) DESIRES POST, Works Manager or Works Engineer ; excellent experience, shop and D.O., erection, steam, gas, furnaces, buildings and chemical plant ; good organiser and used to control ; keen and energetic.—Address, P7246, The Engineer Office. P7246 B

DIESEL ENGINEER, with All-round Experience, England and abroad, DESIRES APPOINTMENT in any capacity, either inside, D.O. outside.—Address, P7304, The Engineer Office. P7304 B

ELECTRIC ARC WELDING.—To Engineering Firms and Public Authorities contemplating Establishing Welding Department.—OWNER DESIRES to COMBINE with GENERAL ENGINEERING BUSINESS ; offers electric arc welding plant and services of experienced mechanical engineer and practical welder in return for salary and commission on net profits or rental for plant. Plant consists of portable Premier electric welding set, Daimler lorry, and necessary accessories.—Address, P7317, The Engineer Office. P7317 B

ENGINEER, Age 30 Years, SEEKS POSITION of responsibility, home or abroad. Good knowledge of building and mechanical engineering, technically trained.—Address, P7290, The Engineer Office. P7290 B

ENGINEER, Exceptional Experience in Heavy Oil and Gas Power, to TAKE CHARGE.—Address, P7310, The Engineer Office. P7310 B

ENGINEER, Excellent Long-service Record as Foreman, draughtsman and works manager with general engineers and ironfounders, SEEKS RESPONSIBLE POSITION ; well-educated, energetic, successful organiser and controller of labour.—Address, P7266, The Engineer Office. P7266 B

ENGINEER, M.I. Mech. E., Now Representing well-known firm in the London area, DESIRES similar or other suitable POST ; 30 years' practical and commercial experience, including 16 years' works and general management.—Address, J., 29, Westbourne-gardens, W. 2. P7210 B

ENGINEER (24), Single, Well-educated, Ex-officer (tech.), thorough general practical training, through all shops and drawing-office, excellent references, SEEKS CHANGE and IMPROVEMENT ; commercial office preferred or where tact, reliability, energy and qualifications will be of service.—Address, P7312, The Engineer Office. P7312 B

ENGINEER WANTS RE-ENGAGEMENT, Charge of Factory or Brewery Plants ; good all-round shop experience (own repairs).—Address, P7320, The Engineer Office. P7320 B

ENGINEER (Working) SEEKS SITUATION. Good all-round experience, fitting, turning, charge of plant ; 1st Class B.O.T. Certificate.—FRANklin, 3 Riverdale-road, Twickenham, Middlesex. P7311 B

ENGINEER, Young, REQUIRES APPOINTMENT ; first-class fitter and turner, gas, steam and petrol engines, also general repair work, maintenance or construction.—Address, P7306, The Engineer Office. P7306 B

HARDENER and ANNEALER (First-class) SEEKS POSITION ; 18 years' exp., used to all types of furnaces, up-to-date steels and py. control. Good refs. ; can take charge.—Address, P7303, The Engineer Office. P7303 B

HEAD of TRAFFIC DEPARTMENT (36) at Large Works closing down SEEKS POST where practical all-round knowledge of railway and traffic matters, including private siding work, principal qualification. Ten years' railway and eleven years' engineering trade experience. Good testimonials.—Address, P7321, The Engineer Office. P7321 B

JOHN HEATH, Cudworth Lodge, Send gate, Surrey, having 21 years' experience of interchangeable production as chief designer, purchaser and works superintendent, &c., accustomed to control large staffs, OFFERS SERVICES in similar capacity or as London Representative. Inquiries solicited. P7327 B

MECHANICAL ENGINEER, B.Sc., 16 Years' Technical, practical, administrative and commercial experience with leading firms, WISHES to NEGOTIATE commercial APPOINTMENT or to act as REPRESENTATIVE where extensive London connection could be utilised.—Address, P7285, The Engineer Office. P7285 B

MECHANICAL ENGINEER (24), B.Sc., WISHES POST at home or abroad. Four years' shops and three years' D.O. experience of steam and oil engines ; knowledge of surveying and aero-engines.—Address, P7300, The Engineer Office. P7300 B

PRACTICAL and Commercial ENGINEER, Returning South Africa, DESIRES commission AGENCIES, first-class firms, presently unrepresented. Exceptional financial references, also to prominent British engineers. Pleased to arrange interviews.—Address, P7289, The Engineer Office. P7289 B

PORTLAND CEMENT.—SPECIALIST, with Extensive practical experience at home and abroad in modern plant operation, works and research chemistry, and field geology (geological surveys, reports on mineral properties, prospecting) relating to the manufacture of cement, would UNDERTAKE similar WORK at home or abroad.—Address, P7302, The Engineer Office. P7302 B

PUPIL, Having Finished Three Years' Time at Messrs. Thornycrofts, Ltd., Basingstoke, REQUIRES ANY POST ABROAD.—Write, Box 8629, Hyam's Advertising Agency, 10, Essex-street, Strand, London, W.C. 2. 2188 B

SECRETARY ACCOUNTANT DESIRES ENGAGEMENT, any capacity. Practical experience of engineers and machinists costing and stores organisation ; thoroughly capable of installing complete system ; practical workshop experience, accustomed to working drawings. Will accept position home or abroad.—Address, P7224, The Engineer Office. P7224 B

WILL ANYONE OFFER ENGINEER EMPLOYMENT ? All-round prac., tech., mech., marine exp. ; held positions works and chief engineer ; accept any berth with sense prospects. Clean record, irreproachable refs., extra 1st class eng. B.O.T., 35, married.—J., S. M., Everton, Coleridge-road, Ashford, Middlesex. P7316 B

WORKS or GENERAL MANAGER. Successful organiser, with many years exceptionally wide experience in both capacities and as chief engineer, WANTS ENGAGEMENT, general engineering, large weldless tubes, hydraulic forging, steel plant and manufactures ; commercial experience.—Address, P7225, The Engineer Office. P7225 B

WORKS MANAGER, with 13 Years' Engineering experience in responsible positions both at home and abroad, WISHES CHANGE. Capable, good organiser, speaks four languages ; in present position for over 3 years ; well acquainted with up-to-date mass production in machine, press shops and cabinet mill. London district preferred.—Address, P7291, The Engineer Office. P7291 B

WANTED, SITUATION as JUNIOR DRAUGHTSMAN, mechanical or constructional. Advertiser has had 2½ years in works, 3½ years in D.O.—F. CLARKE, 203, Kingston-road, Teddington. P7326 B

SITUATIONS WANTED (continued)

DRAUGHTSMAN (Junior), 22, 3 Years' D.O., 2 years' shop experience, jigs and tools, die casting, and general engineering, REQUIRES suitable POSITION.—Address, P7297, The Engineer Office. P7297 B

DRAUGHTSMAN (London District) SEEKS SITUATION ; 18 years' good all-round engineering experience in shops and drawing-office.—Address, P7218, The Engineer Office. P7218 B

DRAUGHTSMAN (Not a Specialist), but with All-round wide experience of mechanical, electrical and structural work, DESIRES SITUATION, London district.—Address, P7313, The Engineer Office. P7313 B

ENGINEER DRAUGHTSMAN (36) WANTS POST. Ten years' supervision of department and D.O., general engineering, foundry, railway experience, first-class references.—Address, P7245, The Engineer Office. P7245 B

SITUATION REQUIRED as CHIEF DRAUGHTSMAN, small office, or ASSISTANT ENGINEER ; experienced mining, mechanical and structural engineering ; 36 years of age ; salary £400.—Address, P7299, The Engineer Office. P7299 B

TURNER and FITTER. Quick and Accurate, 15 years' experience of all-round work. Good refs. ; go anywhere.—Address, P7287, The Engineer Office. P7287 B

COMMERCIAL RECONSTRUCTIONS LTD.
1, POST OFFICE CHAMBERS, DERBY.
Manufacturing and Financial Consultants.
Expert assistance on all works, technical and commercial problems. Production, Costings and Sales. Businesses reorganised and reconstructed. Capital issues and Finance Ex.

PARTNERSHIPS

ENGINEERING PARTNERSHIPS AND BUSINESSES.
Wheatley Kirk, Price & Co.
46, Watling Street, London, E.C. 4.
Established seventy years.

DIRECTORSHIPS.—Large FUNDS AVAILABLE in sums of £3000, £5000, and £10,000 for INVESTMENT in sound Companies having vacant Directorships, which involve attendance at board meetings only. Accountants' investigation will be required of prospective investors' interests. Principals, solicitors, and accountants only replied to.—Write Box 83797, c/o Francis and Co., 131, Fleet-street, E.C. 4. 2189 C

AS MANAGING DIRECTOR.

GENTLEMAN, M.I.C.E., M.I. Mech. E., now holding important but uncertain position, is prepared to NEGOTIATE APPOINTMENT with SUBSTANTIAL and ENTERPRISING ENGINEERING CONCERN. Twenty years' successful management of engineering works and business in London district. Technical and commercial experience. GOOD ORGANISER and NEGOTIATOR. Age under 50. PRINCIPALS OR SOLICITORS ONLY.—Address, 7152, The Engineer Office. P7152 C

TO CONSULTING ENGINEERS AND/OR NAVAL ARCHITECTS.—PARTNERSHIP REQUIRED with established firm by member of leading institute, who has specialised in hydraulicking, dredging and hydrographic work. Foreign and colonial experience. Capital available. Junior partnership would be considered.—Address, 2240, The Engineer Office. 2240 C

WORKS MANAGER REQUIRED for Germany by English Ltd. Co. Investment £2000, salary £750, rising £150 yearly. Must speak German. Every investigation allowed.—Apply, Messrs. TITCHFIELD, Accountants, 23, Great Titchfield-street, Oxford-street, London. P7292 C

EDUCATIONAL

CORRESPONDENCE COURSES for Inst. C.E., Inst. Mech. E., London Univ. (Matric., Inter. and B.Sc.) personally conducted by Mr. TREVOR W. PHILLIPS, B.Sc. (Honours), Assoc. M. Inst. C.E., M.R.S.I., F.R.S.A., &c. Also Day Tuition in Office. Excellent results at all Exams. Courses may commence at any time.—6/11, Trafford Chambers, 58, South John-street, LIVERPOOL. Ex. 8

ENGINEERING EXAMINATIONS.—Day, Evening or Correspondence Courses of Preparation for all Examinations. Thousands of successes during the past eighteen years.—G. P. KNOWLES, M.B.E., B.Sc., A.M.I.C.E., &c., 39, Victoria-street, Westminster, S.W. 1. Ex.

LEARN SURVEYING AND LEVELLING.—Thorough practical instruction given by an expert.—Address, E. MOUL (late L.S.W. and S.P.D. Hlys.), Hollybank, Woking. P6054 B

MISCELLANEOUS

ENGINEERS, Established London Thirty Years, DEVELOP Technically and Commercially Sound ENGINEERING IDEAS on mutual basis.—Communicate first instance to Box E. 466, c/o Dawson's, 121, Cannon-street, E.C. 4. 1679 I

ENGINEERING FIRM, on Main Line Within 10 miles of London, with railway sidings, have building equipped with cupola and other foundry machinery, which they desire to LET to a firm with a view to Joint Working Arrangement.—Address, 2245, The Engineer Office. 2245 I

GOOD COMMISSION Given for INTRODUCTION of GENERAL ENGINEERING and METAL WORK. Introductions treated in confidence.—Address, P7305, The Engineer Office. P7305 I

INVENTORS REQUIRING TECHNICAL ASSISTANCE should apply to DE FRAINE and CLARK, Scientific Engineers, 23, Old Queen-street, Westminster, who will advise design and carry out experimental work. Victoria 858. P7318 I

IF YOU REQUIRE
DIVIDING HEADS for MILLING,
ROTARY TABLES for
SLOTTING and MILLING,
Write to
THE WHEELER MNFG. CO. Ltd.,
65F, Trench Crossing, Wellington, Salop.

For continuation of Small Advertisements see page 3

The Lakeside Electric Power Station at Milwaukee.

No. II.*

A GENERAL view of the main buildings of the plant is given in Fig. 11, but it was taken before the grounds were trimmed and dressed. At the right is the switch-room, with the turbine-room adjacent, in front of which is the smaller auxiliary building, having a machine shop below and station offices above.

FIG. 11—GENERAL VIEW OF LAKESIDE POWER STATION

This upper floor—which also contains reading-room, &c., for the use of the station attendants—has its main approach by a bridge from the higher ground, and spanning an inclined railway track and driveway, which enter the basement of the turbine-room. Beyond this latter room is the boiler-room, with underground flues to two concrete chimneys or smoke-stacks 15ft. in inside diameter and 200ft. high above the ground. To the left of the stacks is the coal pulverising building, with the inclined conveyor gallery from the crusher house.

SITE AND CONSTRUCTION WORK.

As mentioned already, the site is on ground sloping down to Lake Michigan. This is shown partly by Figs. 1 *ante* and 11, but more particularly by the accompanying plan of the main building—Fig. 12. The general level of the ground at the upper part of the plant is about 50ft. above the water, with a steep slope to the shore. The coal crusher plant is built in the sloping ground, as mentioned already.

In planning the machinery lay-out it was desired to provide a suction chamber at the lake level, and to place the condensers at such an elevation that the water could be circulated through them with a minimum lift by pumping. Otherwise an enormous amount of energy would be expended in raising the great quantity of water required for condensing purposes. This determination of the elevation for the condensers, which are arranged—as shown in Figs. 1 *ante* and 13—in turn determined that for the boilers and turbines. The deepest excavation was 20ft. below the water level, or 70ft. below the normal surface of the ground. This was for the intake chamber and turbine foundations. The condenser floor is 1ft. above lake level, and that of the turbine and boiler-rooms is 32ft. above the lake, or 18ft. below the normal surface of the surrounding ground.

Excavation for the site and foundations, including the cuttings for the railway approaches, aggregated 135,000 cubic yards. Most of this was done with a steam excavator and a steam drag-line machine, each fitted with a 2½-yard bucket. For the deepest work, a derrick with a grab bucket was used, but owing to the stiffness of the clay, it had to be supplemented by hand work with the pneumatic chisels used in tunnelling, as described previously. As the branch railway had to be built above the ground level in order to cross public highways, much of the excavated material was used for the embankment and for levelling up the site of the railway yard. This filling was done with trains of narrow-gauge side-tipping cars, the cars being tipped on temporary timber trestles carrying the rails at the level of the top of the embankment. In addition to steel bridges on concrete abutments at the roads, there are culverts of 5ft. concrete pipe in the embankment. The excavation was let to a contractor, who established a camp of 200 men.

Heavy concrete foundations were required, especially as the buildings are in an excavation, and the outer walls had to be designed as retaining walls. These walls and the machinery foundations include about 10,000 cubic yards, while the other work brought up the total to about 25,000 cubic yards of concrete with 1500 tons of reinforcing steel. All this concreting, as well as the masonry work on the buildings, was divided between two contracting companies, each of which maintained a camp for about 200 men on the work. Concrete materials were brought in by the tramway company's trains of large tip wagons operated by electric locomotives. The materials were tipped directly into storage bins holding 300 cubic yards of stone and sand.

From these bins the materials were discharged by gravity through spouts to narrow-gauge trucks, which tipped their contents into hoppers feeding the concrete mixers by gravity. This arrangement of the concreting plant was facilitated by the slope of the ground. Concrete was discharged from the mixer into an elevator bucket, working in a steel tower 200ft. high, the bucket being tipped at the proper height into a hopper feeding an inclined chute for depositing the concrete in place. Cement was stored in a shed at the ground level, directly over the mixer, so that it could be supplied by gravity to the measuring hopper above the mixer. Steel frame construction was used for the turbine-room, boiler-room and coal pulverising building, the frame of this last building supporting a coal bunker of 3500 tons capacity. Including this structural steel work, the bunkers, galleries, stairways and machinery supports, there are about 2250 tons of steel in the buildings. Reinforced concrete framing is used for the switch-room and the office, and machine shop building, while the coal-crushing plant is of reinforced concrete throughout.

Brick walls faced on the outside with red pressed brick and stone trimmings are used for the main buildings. The roofs are mainly of 3in. and 4in. concrete, covered with tar and gravel composition. Over the turbine-room and switch-room, where condensation on the underside of the roof slab might cause trouble, a layer of 3in. hollow tile was placed on the concrete slab and covered with a ½in. coat of cement mortar, upon which the tar and gravel composition was laid. Rolled steel frames and steel sash glazed with wire-glass are used for the windows and the monitor or clerestory lights. Skylights and flashings are of copper. The down pipes are of galvanised wrought iron pipe with cast iron gutter boxes. Tile flooring is used in the operating parts of the switch-room, turbine-room and boiler-room, and also in the offices. The interior of the turbine-room is faced with straw-coloured glazed brick trimmed with brown enamel brick and cut stone.

Drinking water is distributed though the power-house from an artesian well. Service water is pumped from the main intake well. Modern plumbing facilities are provided, and the offices and switch-room are supplied with steam heat. A 125-ton overhead electric travelling crane, of 90ft. span, serves the turbine-room. It has two main hoists of 62½ tons capacity each, and a 5-ton auxiliary hoist. As the switch house has five stories containing the electrical equipment, it is served by a 1-ton electric elevator or lift. A similar lift serves the machine shop and store-room.

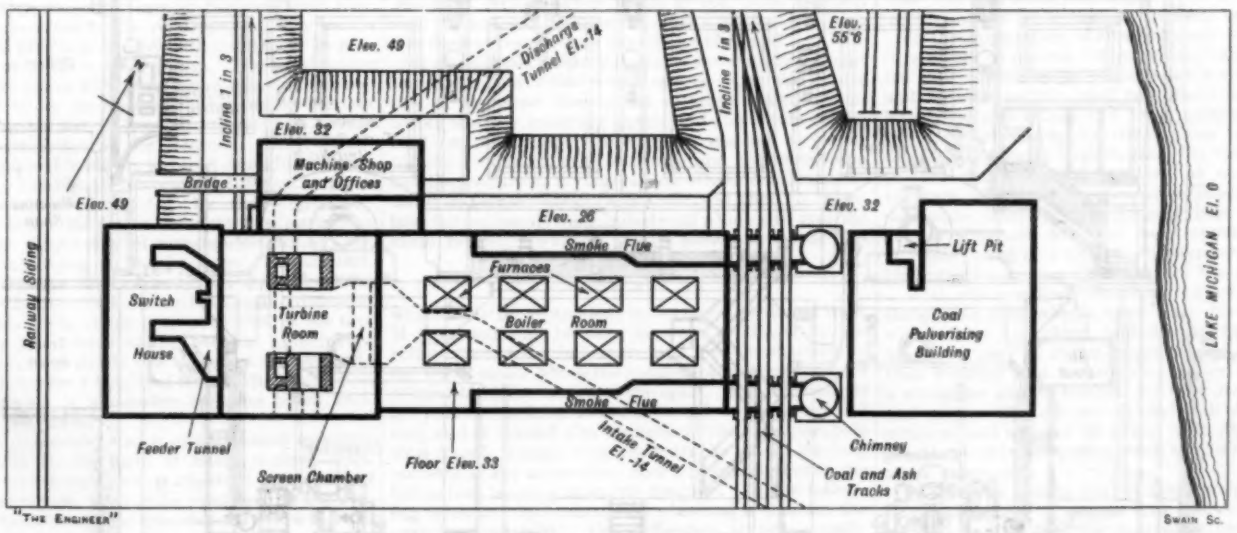


FIG. 12—BLOCK PLAN OF MAIN BUILDINGS

MAIN POWER EQUIPMENT.

Sections through the turbine-room, showing the arrangement of the machinery, are given in Figs. 1 *ante* and 14. The two main units now installed are 20,000-kilowatt turbo-generators, 13,200 volts, three-phase, 60-cycle, operating on 250 lb. steam pressure, with 200 deg. Fah. superheat and 1in. absolute back pressure. Each unit has the following auxiliaries:—A three-pass Wheeler condenser of 35,000 square feet; two 24in. circulating pumps, of 18,000 gallons per minute, are driven by a 170 horse-power motor and the other by a 170 horse-power steam turbine;

* No. I. appeared April 13th.

THE LAKESIDE ELECTRIC POWER STATION AT MILWAUKEE

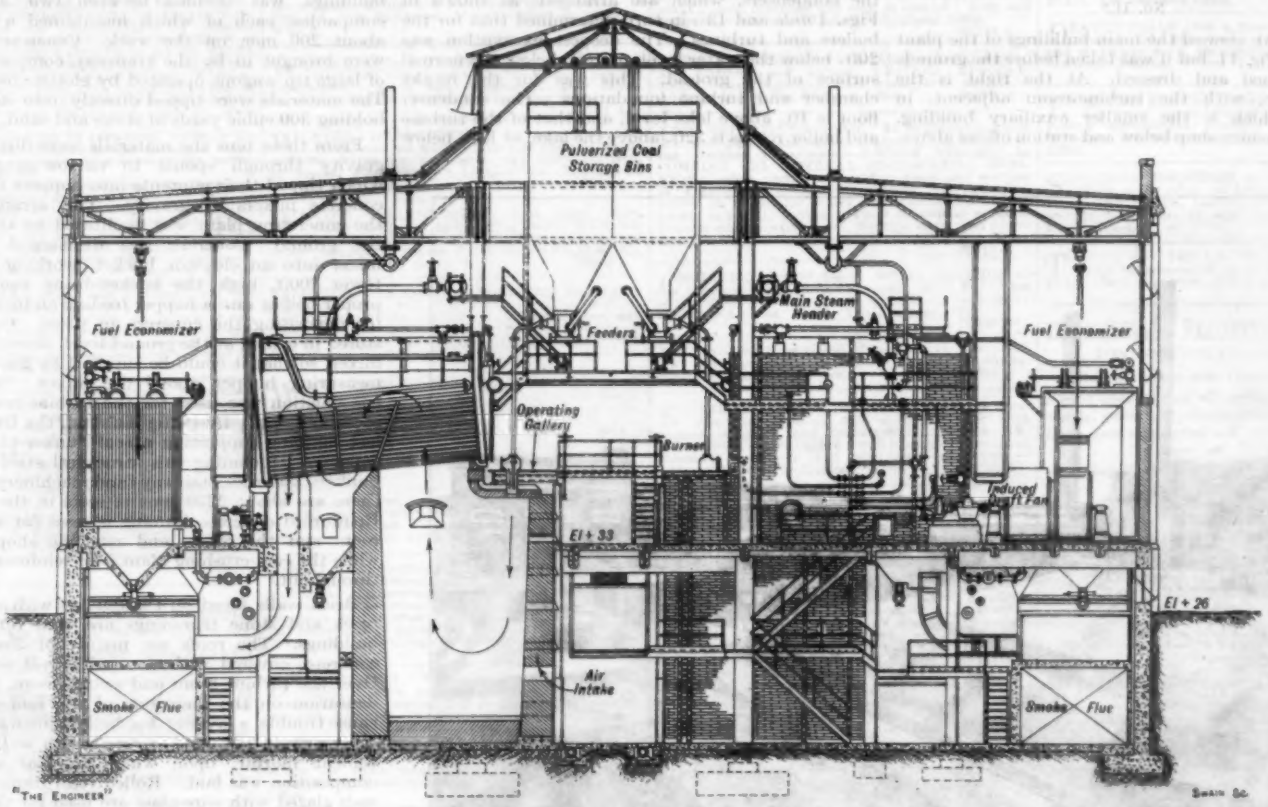


FIG. 13—CROSS SECTION THROUGH BOILER HOUSE

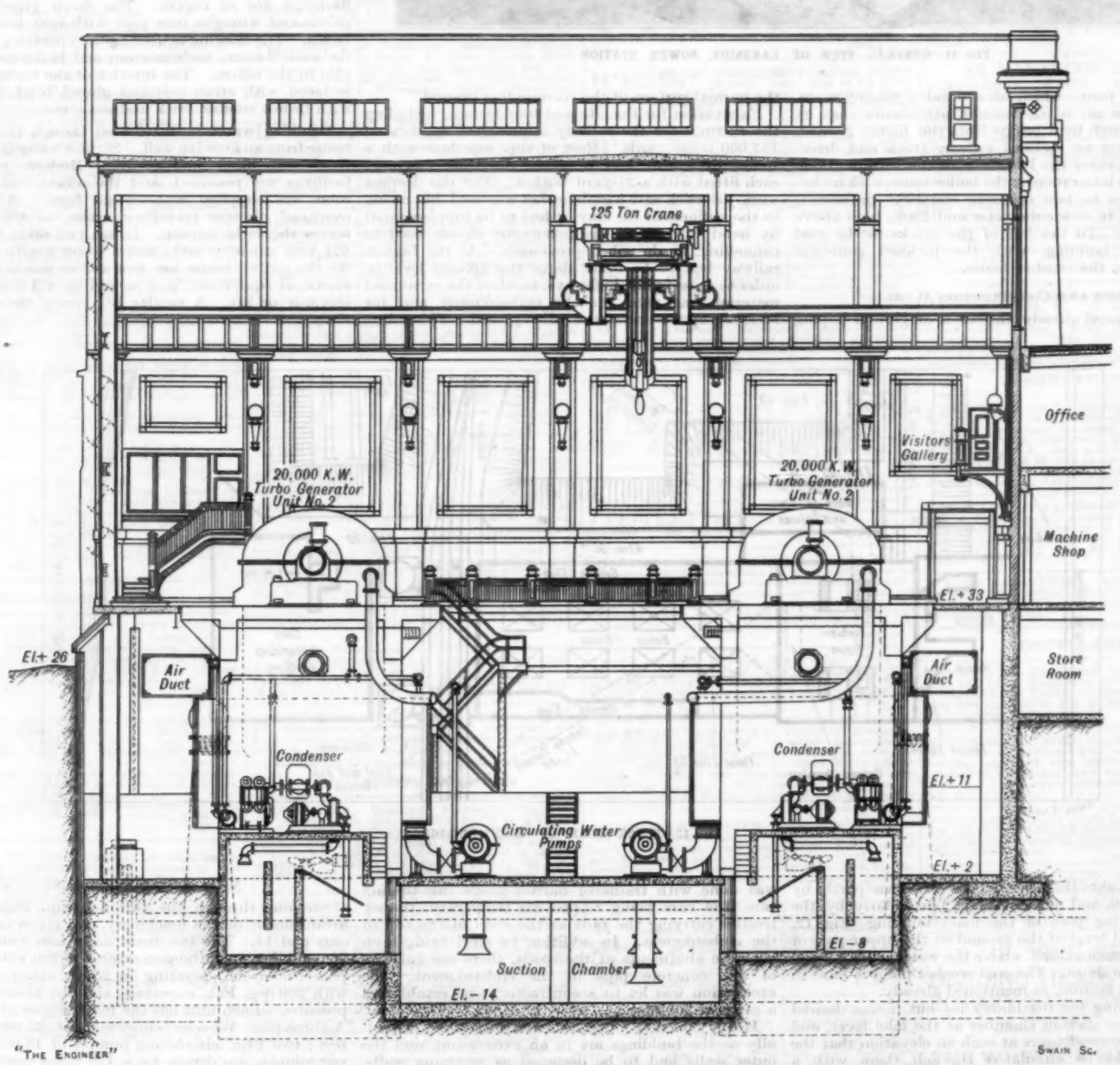


FIG. 14—CROSS SECTION THROUGH ENGINE HOUSE

a condensate pump, driven by a 50 horse-power motor; a turbo air-pump, driven by a 100 horse-power motor; and a steam jet air-pump. As a rule, only one circulating pump will be in service, but both will be required during the summer, when the water is warm. Cooling water is taken from the intake bay, already mentioned, and flows to a screen well in the basement of the turbine-room—Fig. 12—where it passes through the travelling screens before entering the condensers. With this arrangement of the well, the screens can be handled by the overhead crane of the turbine-room.

Air enters the turbine-room through window ventilators in summer and through the roof monitor or clerestory in winter. Each generator has an air washer which takes the supply direct from the room. This air is discharged by the generators into the basement of the boiler-room by means of sheet iron conduits, the heated air being thus used to supplement the main supply to the boiler furnaces. A by-pass arrangemgnt provides for returning part of the air to the turbine-room in cold weather, so as to maintain a suitable room temperature. For fire protection, automatic dampers have been placed as close to the generator as possible in both the intake and discharge conduits. High-pressure steam can also be admitted in case of fire. Sanitary service pumps are so connected as to be available for reserve boiler feed-tank service. The station equipment includes an air-compressor for cleaning the generators, for operating pneumatic tools, boiler-tube cleaners and for other purposes.

Boilers and Economisers.

The arrangement of the boilers and boiler-house equipment is shown in the main longitudinal section—Fig. 1 *ante*—and the cross section herewith—Fig. 13. A view of the boiler fronts is given in Fig. 15, the firing floors being the two galleries along either side side of the central aisle. All valve control for the burners is arranged on these galleries. On the floor below are a number of air dampers, some of which appear in the picture, but most of them are now permanently covered by refractory brick housing. Fig. 16 is a rear view of the boilers and fuel economisers.

We have in former issues discussed the boiler plant, so that it will not be necessary to describe it in detail in the present instance. We may say, however, that there are eight horizontal Edge-Moor water-tube boilers, each having a heating surface of 13,060 square feet, arranged in two batteries on each side of a firing floor. They are designed for 300 lb. pressure, but work ordinarily at 265 lb. With normal operation three boilers are sufficient to supply steam to a 20,000-kilowatt turbo-generator unit, leaving one boiler in each battery for reserve or cleaning. Each boiler is fitted with a Foster superheater of sufficient capacity to increase the temperature of 90,100 lb. of steam per hour from 411 deg. to 611 deg. Fah., thus realising a superheat of 200 deg.

Pulverised coal from the bins over the firing floor, which have been described before, is fed to the furnaces by screw conveyors, and is discharged downwards into the combustion chamber by vertical burners of the Lopulco type, as used at the company's Oneida-street station. Two of the boilers were at first equipped with horizontal discharge burners of the Fuller type for experimental purposes, but they were later converted to the vertical type. By means of baffles the products of combustion are made to pass four times over the nest of tubes. The combustion chambers are about 26ft. deep below the boiler tubes.

For each boiler there is a Sturtevant economiser with 7603 square feet of heating surface, and having a by-pass connection to the chimney. Each economiser is equipped with an induced-draught turbine-driven fan. Feed-water entering at 140 deg. is raised to a temperature of 255 deg. by the economiser. From each boiler battery a concrete flue leads to a chimney, the flues being of rectangular section, 8ft. wide, and increasing in height from 11ft. to 18ft. The two chimneys of reinforced concrete are 220ft. high above the foundations, with an inside diameter tapering from 16½ft. at the bottom to 15ft. at the top. The shell is 24in. thick at the bottom, reducing to 6in. at the top, but inside this there is a 4in. concrete protective lining for a height of 60ft. The foundation of each chimney is a massive concrete block 28ft. square and 6ft. thick.

Ash from pulverised coal is of very small quantity and is mainly in the form of finely divided dust. To handle this accumulation there is a system of steam-jet conveyors, with main runs serving the ash-pits of the furnaces, while branch runs serve the ash hoppers at the back ends of the boilers and soot pits under the economisers. The ashes are discharged into an elevated bin at the east end of the boiler-house, from which they are delivered by gravity spouts into railway wagons.

Feed-water pumped from the suction pit under the turbine-room—which is fed by a 10ft. tunnel from Lake Michigan—is delivered to heaters having a hotwell tank for the condensate pumped from the two main condensers of the steam turbines. In this way the water is heated to about 140 deg. An overflow from the hotwell feeds a reserve feed-water basin below the floor of the boiler-room basement, from which basin water is reclaimed by a centrifugal pump and delivered to the overhead hotwell as required.

From the heaters the feed-water flows through a notch meter which is on the upper floor, and gives a 15ft. suction head on the feed pumps. This meter has a capacity of 800,000 lb. per hour. In addition, there is a test meter of the same type, of 300,000 lb. capacity, on a pipe line with connections from the condensate pumps on the condensers. This latter is above the level of the overhead hotwell tank, thus giving a gravity flow to the heaters.

The feed-water pumps include two 6in. centrifugal pumps of 650 gallons per minute, driven by 250 horse-power steam turbines, and two 4in. centrifugal pumps of 400 gallons per minute, driven by 150 horse-power motors. With eight boilers working at 250 per cent. rating, the maximum quantity of feed-water required is 1450 gallons per minute. This leaves one steam pump or two motor-driven pumps for reserve.

Heat-balance Arrangements.

In order to obtain a well-balanced heat condition for use in connection with heating the feed-water to a suitable and regular temperature before delivering it to the economiser, it was decided to install steam-driven boiler-feed pumps, induced draught fans and half of the circulating pumps capacity. This arrangement leaves the balance of steam required for feed-water heating to be supplied in varying quantities by the house unit or so-called heat balancer. All other auxiliaries are directly driven by motors.

This heat-balancer unit is a 500-kilowatt turbo-generator, which supplies current at 480 volts for station use. Its turbine end is equipped with a governor operated from a diaphragm which is controlled by a thermostatic device in the feed-water heaters. In this way the feed-water temperature is regulated by varying the amount of exhaust steam passing into the heaters from this turbine. The electric load on the generator end is balanced through a transformer connected to the main station buses. With the aid of this balancer unit the main turbo-generator units can be started under a vacuum in case of complete isolation from any outside source of power, since the balancer can supply current to operate the electrical auxiliaries of the condenser.

The operating economy of the station when completed and operating at full load factor will be that resulting from a combined boiler, furnace, superheater and economiser efficiency of 88.15 per cent., using Illinois soft coal of approximately 11,000 B.Th.U. heat value as delivered at the station.

Equivalent Loads on Bridges.

By P. H. PARR.

The bending moment curve due to a rolling load passing over a bridge is commonly replaced by the parabolic bending moment curve produced by the "equivalent uniformly distributed load"—that is, by that from the uniformly distributed load which gives a bending moment diagram just covering the one from the actual rolling load. The calculations for determining these equivalent loads for one or more locomotives, on bridges of various spans—say, from 10ft. to 150ft.—though not difficult, are decidedly tedious when made in the usual manner, and this article is intended to show a method by which the desired results may rapidly be obtained.

It is well known that the maximum bending moment under any particular wheel occurs when the centre line of the span bisects the distance between that wheel and the centre of gravity of the whole rolling load on the bridge. A common method of determining the equivalent load is to find this maximum bending moment, trying various wheel combinations until the greatest effect is obtained and then to calculate the uniformly distributed load which will give the same bending moment at the same place, that is—

$$W = \frac{4\,l\,M}{l^2 - x^2} \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where W is the equivalent uniformly distributed load, M the maximum bending moment produced by the rolling load, l the half-span, and x is the distance of the wheel under which the maximum bending moment occurs, from the centre of the span. The calculations are tedious when a number of cases have to be worked out, and it should also be noticed that the parabola thus found, though it agrees with the actual bending moment at its maximum, does not usually cover the full actual bending moment diagram. In the following notes the equivalent load obtained is that for the covering parabola; the difference is not usually great, but from some points of view it is better to know the covering value, whilst actually the calculations are more simple.

If w = the total rolling load on the bridge,
W = the total equivalent uniformly distributed load,
m_1 and m_2 = the moments of the loads on each side of the wheel under which the bending moment is to be considered, about that wheel, m_1 being the greater, unless they are equal,
b = the distance of the centre of gravity of the total load from the wheel under consideration, being, of course, $b = (m_1 - m_2)/w$,
L = the whole span of the bridge,
l = the half-span of the bridge, and
x = the distance from the wheel under consideration to the centre of the span, positive when the centre is on the same side of the wheel as is the centre of gravity of the total load.

Then the bending moment under the wheel is evidently—

$$M = \frac{w\,(l + x - b)\,(l - x)}{2\,l} - m_2 \quad . \quad (2)$$

Substituting this value of M in (1), reducing, and noting that $w\,b + m_2 = m_1$, gives the equivalent load as—

$$\frac{W}{2} = w - \frac{m_1}{l + x} - \frac{m_2}{l - x} \quad . \quad . \quad (3)$$

Differentiating with respect to x and equating to zero, to find the value of x for which W is a maximum, gives—

$$x^2 - 2\,c\,l\,x + l^2 = 0 \quad . \quad . \quad . \quad . \quad . \quad (4)$$

where $c = \frac{m_1 + m_2}{m_1 - m_2}$, so that, since $x < l$, the maximum value for W occurs when—

$$x = l\,(c - \sqrt{c^2 - 1}) \quad . \quad . \quad . \quad . \quad . \quad (5)$$

and for this value of x equation (3) gives, ultimately—

$$W = 2\,w - \frac{2\,(\sqrt{m_1} + \sqrt{m_2})^2}{L} \quad . \quad . \quad (6)$$

which is readily evaluated in any given case. One of the radicals can be removed by writing $m_2/m_1 = r$, when we find—

$$W = 2\,w - 2\,(1 + \sqrt{r})^2\,\frac{m_1}{L} \quad . \quad . \quad (7)$$

which is probably the simplest form in which it is possible to offer the required expression. The factor $2\,(1 + \sqrt{r})^2$ can readily be found on an ordinary slide rule, or, since r always lies between 0 and 1, a comparatively small table of the values is sufficient for all cases. A few values are given in Table I. under column F, and for many purposes, if $r > 0.3$, it is sufficient to take $F = 3.75 + 4.25\,r$.

Table I.

r.	F.	r.	F.	r.	F.
.00	2.000	.35	5.069	.70	6.749
.05	2.996	.40	5.327	.75	6.964
.10	3.464	.45	5.584	.80	7.174
.15	3.848	.50	5.828	.85	7.388
.20	4.188	.55	6.067	.90	7.597
.25	4.500	.60	6.301	.95	7.801
.30	4.793	.65	6.533	1.00	8.000

For the end wheel of a set we have $m_2 = 0$, giving $r = 0$, and then equation (7) gives $W = 2\,w - 2\,m_1/L$ for the covering parabola. It is readily found that this corresponds to $x = l$, or to the wheel being right at the end of the bridge. In this case it seems better not to take the full cover with the parabola, but to restrict x to a smaller value; if we take $x = l/3 = L/6$ as a maximum, we shall have $F = 3$ and $r = 0.05$, and we may restrict the use of equation (7) to the cases where $r > 0.05$, and for those cases where $r < 0.05$, take—

$$W = 2\,w - \frac{3\,m_1}{L} \quad . \quad . \quad . \quad . \quad (7a)$$

This point is usually of importance only for bridges of such length as to take two wheels only at once.

In the application of these formulæ to actual cases it is better to reverse the common practice of finding the load combinations to be taken for various spans, and to take certain load combinations, then calculating the equivalent W's for a number of different spans, which is rapidly done, since the curves are simple rectangular hyperbolas. On the curves being plotted the intersections show at once the limits between which the various combinations give the maximum effects. The limiting line to which the curves approach for very long spans, or $W' = L \times$ (total weight of engine and tender)/(length over buffers), should also be drawn on the diagram.

With this method, after the curves for one, two, three, and four wheels have been drawn, groups of wheels may be added each time; thus from four wheels we may go to the complete engine and tender; then we may add a complete tender in front, then a complete engine behind, next an engine in front, and so on. The curves are each calculated in a few minutes, and tangent lines can be drawn with much greater confidence than is given by the isolated points often calculated.

It is worth noting that if the "weight per foot" = (total weight of engine and tender)/(length over buffers) = d, so that the equivalent limiting load for very long spans is $W' = L\,d$, and the actual equivalent load for a given combination of wheels is $W = c - f/L$, then the span at which the excess of W over W′ is a maximum is given by—

$$L = \sqrt{\frac{f}{d}} \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

and, if desired, the calculations for the W's may be made for these spans only, with the certainty that they will give the peaks of the complete curves.

As an example of the use of the above formulæ, we will find the equivalent loads for the engine and tender shown in Fig. 1. We may first draw the limiting equivalent load line, $W' = 1.91$ L, as shown in Fig. 2. Then, for a single wheel, W is twice the

weight on the most heavily loaded wheel, or 40 tons in this case, and we draw the horizontal line at W = 40 to represent the equivalent load for one wheel on all spans.

For two wheels those to be chosen are evidently Nos. 3 and 4, and we must use equation (7*a*). We have $w = 20 + 20 = 40$, and $m_1 = 20 \times 9 = 180$, so that $W = 80 - 540/L$, and the values for a few spans are found in a few minutes, from which the curve 3, 4 on Fig. 2 can be plotted.

For three wheels the selection evidently lies between 2, (3), 4 and 3, (4), 5, the number in brackets indicating the wheel under which the bending moment is to be taken. The combination which will give the greatest value to W cannot always be settled by inspection only, but large values for w and also for r are usually most effective. For 2, (3), 4 we have $w = 50$, $m_1 = 180$, $m_2 = 80$, and $r = 0.445$; for 3, (4), 5 $w = 55$, $m_1 = 180$, $m_2 = 150$, and $r = 0.833$, so that both w and r are greater for the second combination, which may therefore be expected to give the higher results. Adopting, then, the combination 3, (4), 5, we have $2(1 + \sqrt{0.833})^2 \times 180 = 1317$, giving $W = 110 - 1317/L$, and the curve 3, (4), 5 of Fig. 2 is soon calculated. The curve 2, (3), 4 is also indicated on Fig. 2, showing that it really does fall below the one selected.

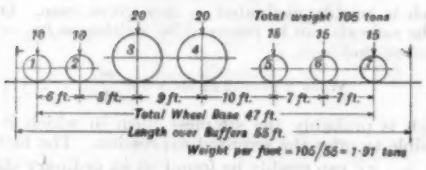


FIG. 1

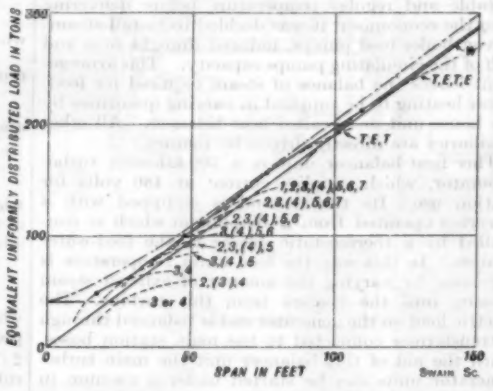


FIG. 2

For four wheels, 2, 3, (4), 5 gives $w = 65$ and $r = 0.429$, whilst 3, (4), 5, 6 gives $w = 70$ and $r = 0.445$, so that we may expect the second combination to give the higher result. It does do so for spans above 30ft., and for shorter spans the effect of the three-wheel combination is greater than that of either, as seen on Fig. 2.

For five wheels we must evidently take 2, 3, (4), 5, 6; for six wheels we add on No. 7, and for seven wheels we add on No. 1, or take the complete engine and tender, for which it will be found that $W = 210 - 5300/L$. Also, the span at which $W - W'$ is a maximum is, from equation (8), given by $\sqrt{\frac{5300}{1.91}}$ = 53ft., for which W = 110 tons.

We may now take longer steps. Adding a complete tender in front of the engine and using the driving wheel No. 3 as base, we find $w = 150$, $m_1 = 1410$, and $m_2 = 1350$, giving $W = 300 - 11{,}000/L$, and the curve is shown on Fig. 2 as T E T (tender, engine, tender). $W - W'$ will be a maximum for $L = \sqrt{\frac{11{,}000}{1.91}} = 76$ft. Next adding a complete engine behind the tender, giving T E T E and using the trailing wheel No. 4 as base, gives $w = 210$, $m_1 = 3485$, $m_2 = 2290$, and $W = 420 - 22{,}800/L$, while the maximum excess occurs at $L = \sqrt{\frac{22{,}800}{1.91}}$ = 109ft. For these longer spans the points of maximum excess may be joined by straight lines and the calculations rapidly extended to any span desired.

The complete curves, as described above and shown in Fig. 2, indicate very clearly the full effects of the rolling load on any span and readily account for the apparently curious irregularities sometimes seen on plotted curves of equivalent loads, which have been made for certain selected spans, when the points found are irregularly placed on the crests or near the intersections of the curves, without any indication of such actually being the case.

On Fig. 2 there is shown, by the chain-dotted line, the standard allowance for bridge designing adopted by one of the leading railway companies. It will be seen that the engine of Fig. 1 could run over all the bridges of this company so long as they were in good condition, but that the margin is very small for bridges between 50ft. and 90ft. span, so that any slight weakness developed by such bridges would at once cause the civil engineering department to forbid the engines to pass over them.

At the inquiry on the 10th inst. for a Provisional Order for the Glasgow Corporation to take over the Glasgow Subway, the premable of the scheme was approved.

Corrosion of Metals.

The meeting convened under the joint auspices of the Faraday Society, the Sheffield Section of the Institute of Metals, and the Manchester Metallurgical Society, which was held at Sheffield University on April 13th, attracted an excellent attendance and produced some interesting contributions to the literature of the subject under discussion.

Sir Robert Robertson, the President of the Faraday Society, in a brief introductory address from the chair, commented on the appropriateness in the metropolis of the steel industry of discussing the measures to be taken to preserve steel and other metals from the wasteful effects of corrosion. The loss due to corrosion was not inevitable, and progress was being made in the elucidation of the problems involved. Methods had been devised to prevent the corrosion of steel by sea water, and those associated with the chemical industry had had placed at their disposal materials which resisted the corrosive effects of acids. He hoped that means would be found of preventing the corrosion of the metals used for constructive purposes. The holding of a joint meeting of the three societies emphasised the need of co-ordinating the research work on the subject, and a stage had been reached when it was desirable to make a review of the knowledge which had been gained. He hoped that that day's discussion would throw fresh light on the subject and indicate the lines of further research work.

Professor C. H. Desch said the subject of corrosion had been discussed from many points of view during the last few years, and there had been during that period remarkable developments in knowledge of the subject. Until comparatively recently one general method of investigating corrosion had been by loss of weight, a purely empirical test. Another method of attacking the subject was the more theoretical one of applying the electro-chemical principle and arranging materials in the order of the electro-chemical series, but it had been shown to be a delusion and that this order had nothing to do with corrosion. It had been realised that physical and mechanical tests were of considerable importance, and valuable work had been done by Dr. Bengough. It was now known that in the case of many alloys the resistance to corrosion was not an inherent quality, but was due to the nature of the first corrosive product. The work of Longmuir had shown the importance of the surface film in connection with corrosion, and Mr. Evans had also investigated the subject of passive layers at the surface of metals. It was in this direction that progress was now being made. While the simple electro-chemical theory did not help very much and the loss-of-weight test was only empirical, yet by a combination of these and other methods and by the use of the microscope for the study of surface films, it should be possible to arrive at a definite opinion with regard to the mechanism of corrosion. Proof had been given that it was the mechanism of the first stages of corrosion that was the determining factor. The theory of the subject was still imperfect, and in the contributions to be presented to that meeting some interesting facts were recorded which would assist progress. He might point out that, as Dr. Armstrong had reminded metallurgists, the theory of the subject was laid down long ago by Faraday, and even to-day the best foundation for its study was the series of experimental researches, made many years ago by Faraday, in which the fundamental conditions of chemical change were presented in a way which it had never been necessary to alter.

Industrial Metals.

The task of opening the general discussion was entrusted to Dr. W. H. Hatfield, who took for his subject the corrosion of industrial metals. Looked at from the industrial standpoint it was not, he insisted, quite so important that an adequate theory should be devised as that progress should be made in the development of metals and alloys suitable for meeting the demands of the mechanical arts. The conditions of service required might include variations of the condition of the metal, temperature, pressure, chemical and physical environment, including contact with other metals. Indeed, conditions of service might be so variable as to make a quantitative ordered mapping out of knowledge impossible. It was not feasible, therefore, to produce a simple working theory. Friend's investigations had materially increased knowledge of the corrosion of iron and steel, and his theory successfully explained most of the known facts of ferrous corrosion. In seeking for a theory which could be generally applied, Bengough and Stuart's colloidal theory was very plausible. These two theories owed their origin largely to the failure of the electrolytic or electro-chemical theory to explain observed corrosion phenomena, although at the same time it could not be doubted that the electro-chemical effect was an important factor in many cases. Contrary to what would be anticipated from the electro-chemical theory, some of the most resistant alloys, namely, nichrome, stainless steel, and tantiron, belonged to the heterogeneous series, but even homogeneous alloys possessing resistant properties, including monel metal and aluminium, became heterogeneous owing to the percentage of impurities present. The tables presented by Dr. Hatfield recorded some very interesting results, including the fact that variable acid attack on commercially pure iron and carbon steel is no indication of relative merit against the attack of other selected corroding media. Wrought iron was shown to be very susceptible to sulphuric acid attack, owing probably to the high phosphorus content and the presence of manganese. It was also shown that nickel steel is very resistant to sulphuric and chrome steel is very resistant to nitric acid, two conspicuous examples of the addition of a minor proportion of an element conferring a new property upon the metal. Manganese steel is very susceptible to general corrosion. Much of Dr. Hatfield's work has, as he stated, been upon the 12 to 14 per cent. chromium stainless steel, and some anomalous results had been obtained. For example, it had been found that 5 per cent. acetic acid attacked this steel, while vinegar, which contained from 4 to 5 per cent. of acetic acid, did not. Citric acid of practically all strengths attacked it, but lemon juice and lime juice, of which citric acid is a dominating constituent, did not. Again, lactic acid attacked it, yet sour milk, of which the acid was an important constituent, was without action. Arising out of the investigations of Bengough and Stuart, Mr. Woolman has, Dr. Hatfield said, carried out a series of experiments with a view of determining the relation between surface tension and liability to corrode, but the results were somewhat indefinite. Dr. Hatfield stated, in conclusion, that his experience led him to conclude that there were now available alloys and steels effective in resisting ordinary corroding influences. These different alloys, while at times resisting the same media, did not give the same response to other media, and it was necessary that actual practical experiments should be made in connection with the particular application which was desired, as not only composition but also concentration, temperature, and extraneous influences must be considered. There was no obvious law or set of laws at present available, nor any working theory sufficiently satisfactory to render effective aid to the worker on corrosion.

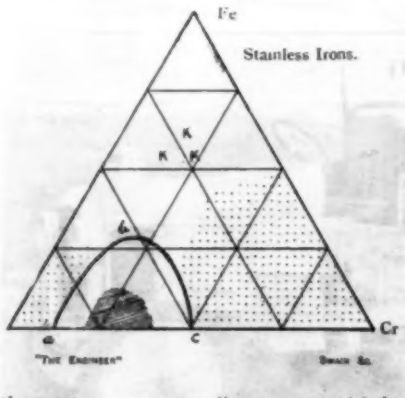
Influence of Heat Treatment.

The resistance of stainless steel and iron to corrosion was also dealt with by Mr. J. H. G. Monypenny, Chief of the Research Laboratory of Brown Bayley's Steel Works. He pointed out that in addition to differences in chemical composition the properties of the material as regarded resistance to corrosion might be profoundly modified by various forms of heat treatment, a fact which had not hitherto been sufficiently recognised. It had been found that the greatest resistance was obtained by quenching from a temperature sufficiently high to dissolve all the carbide in the steel, while the sudden and marked fall in hardness, which was produced on tempering at between 500 deg. and 600 deg. Cent., was accompanied by a lessened resistance. The actual microstructure obtained on annealing stainless steel depended on the maximum temperature reached during the annealing process. Work in progress suggested that the ferrite after annealing contained less chromium than after hardening and tempering. The non-corrosive properties of material annealed at a temperature high enough to give an ordinary pearlitic structure were of comparatively little importance, as the mechanical properties of the material were poor. Mr. Monypenny also referred to the effects of cold work on resistance to corrosion. It was known, he said, that most metals, including stainless steel, when distorted by cold work, had a greater tendency to corrode than when in the normal condition. With regard to the effects of variation in composition, experiments had demonstrated that for any given chromium content and with definite conditions of heat treatment, the resistance to corrosion would be greater the lower the carbon content, while conversely with constant carbon an increase in the chromium content was associated with added resistance. That conclusion was, however, complicated by the fact that from the commercial point of view mechanical properties were as important as non-corrodibility, and for that reason and because the cost of the higher chromium alloys was inclined to be prohibitive, the

amount of chromium in stainless material ranged between 11 and 14 per cent. The effect of the presence of silicon was to raise the critical ranges so that in order to produce the same hardening effect, and, what from the point of view of corrosion was very important, *i.e.*, the same solution and diffusion of the carbide, higher temperatures were required for hardening. Up to about 1 per cent. the presence of silicon had very little effect on the resistance of the material to corrosion. Most samples of stainless steel contained small amounts of nickel, generally less than 1 per cent., and higher nickel content increased the resistance of the material to the attack of mineral acids. In concluding an interesting review of the subject, Mr. Monypenny dealt with the resistance of stainless material to various corroding agents. He showed that the attack of nitric acid presented several interesting features. Very dilute solutions attacked stainless material slowly, the rate of attack decreasing with increasing content of chromium and decreasing carbon content. The stronger acids used in analytical work were, he said, practically without action on the steel. The results of test samples placed in steam pipes showed that stainless steel resisted the action of steam remarkably well, remaining unaffected after several months' exposure to slightly superheated steam at a pressure of 120 lb. per square inch. The material also resisted erosion.

Nickel-chromium Iron Alloys.

A more limited aspect of the subject, the heat and acid-resisting properties of certain nickel-chromium and nickel-chromium iron alloys was dealt with by Mr. J. Ferdinand Kayser. All the commercially useful alloys fell, he reminded the meeting, within 10 and 50 per cent. chromium, alloys containing more than the maximum figure named being almost uncastable on account of their extreme viscosity. There was, however, nothing to be gained by the use of an alloy containing more than about 35 per cent. of chromium, and the high cost of the material had led to the chromium being used as ferro-chromium, thus introducing a certain percentage of iron. Mr. Kayser gave a phase-diagram, which is reproduced,



the three corners corresponding to pure nickel, iron and chromium. In Mr. Kayser's opinion most of the heat and acid-resisting alloys fall within the area *a b c*. He said that the zone marked K had been exploited to some extent by German investigators in the search for an acid-resisting alloy, and it would be desirable if English metallurgists would give their attention to this zone. All the alloys falling within the area *a b c* had similar characteristics. Besides iron, nickel, and chromium other ingredients were often present, the most important being carbon, silicon, aluminium, manganese and copper. Aluminium had been shown to have a remarkable hardening influence upon nickel and nickel-chromium alloys. The addition of 5 per cent. of silicon and upwards gave an intensely hard and brittle alloy but reduced the resistance to the action of sulphur dioxide. Some alloys contained considerable percentages of copper, but no advantage was secured thereby. The composition of several typical commercial alloys, referred to by Mr. Kayser, are shown in the following table :—

	C.	Mn.	Si.	Cr.	Ni.	Co.	Al.	Cu.	W.	Mo.	V.	Fe.
1.	.94	1.1	1.9	21	68	Nil	Nil	Nil	Nil	Nil	Nil	7
2.	.27	.06	3.92	29.1	62.4	Nil	Nil	Nil	Nil	Nil	Nil	4.9
3.	.09	.02	.46	15.6	81.2	1.56	.42	Nil	Nil	Nil	Nil	.8
4.	.5	.79	.80	13.68	57.5	Nil	Nil	Nil	Nil	Nil	Nil	27.3
5.	—	.08	1.04	21.07	60.7	Nil	1.09	6.42	2.13	4.7	Nil	.76
6.	1.13	2.2	.63	15.5	64.9	Nil	Nil	Nil	Nil	Nil	Nil	15.8
7.	.68	1.44	.22	10.8	62.7	Nil	Nil	.108	Nil	Nil	Nil	24.07
8.	1.37	1.00	.49	8.5	40.0	Nil	Nil	5.5	Nil	Nil	Nil	42.0
9.	.60	1.88	1.17	13.2	59.9	Nil	Nil	Nil	Nil	Nil	Nil	23.2

As a result of numerous experiments it had been found, said Mr. Kayser, that none of the complex alloys on the market had a solidus higher than the melting point of nickel. The alloys in the table were mainly intended for use at high temperatures. Their corrosion resisting properties varied according to composition, but it had been found that if the silicon did not exceed 2 per cent. and the combined carbon, silicon and manganese 4 per cent., the properties of the alloys falling within the shaded portion of the area *a b c* of the equilateral triangle were very similar indeed. The most remarkable property of nickel-chromium alloys was their resistance at any temperature below the melting point to the scaling action of furnace gases of either a reducing or oxidising nature. The claim made in trade pamphlets that nickel-chromium alloys were quite resistant to the action of sulphur in furnace gases had not, however, been substantiated.

Monel Metal.

Mr. John Arnott gave a short account of the use as a non-corroding material of Monel metal. He said that its sphere of use, owing to its excellent physical properties, was different from that of the acid-resisting metals which had to be employed in many cases in spite of their poor mechanical properties. Monel metal was not suitable for use with strong acids, but it was very little affected by exposure to the atmosphere, had an absolute resistance to the effects of sea water, and was unaffected by wet, saturated, or superheated steam. An important property of the material was the retention of strength and ductility at temperatures above the normal. A point which had been brought out in recent experiments was that the resistance to corrosion was very well indicated by the Brinell hardness number, the resistance to corrosion increasing with the rise in the hardness number. The experiments carried out by Mr. Arnott for Messrs. G. and J. Weir, to whom he expressed his indebtedness for permission to publish the data, indicated that Monel metal was suitable for parts which had to resist sea water, impure water, steam, and dilute acid solutions and alkali solutions.

Dry Corrosion.

The mechanism of the so-called dry corrosion of metals was the subject of a long contribution by Mr. Ulick R. Evans. He dealt with the influence of volatile electrolytes, the influence of contact between dissimilar metals, and the general mechanism of corrosion. His experiments on the behaviour of apparently dry metals roughened with emery had indicated, he said, that no corrosion occurred when they were kept over sulphuric acid, and only slow superficial corrosion when they were kept over water. The rate of attack was greatly increased by the presence of volatile electrolytes in the air, sulphur dioxide being most dangerous to iron and nickel, ammonia to copper and its alloys, and hydrogen chloride to zinc and aluminium; hydrogen sulphide and carbon dioxide somewhat increased the rate of rusting of iron, but produced only superficial changes on other metals. Contrary to popular belief, the corrosion of iron was not caused by the presence of ammonia. Corrosion of metals by volatile electrolytes appeared to require the presence of some moisture, but proceeded in air which was distinctly unsaturated. Special phenomena occurred at the contact of dissimilar metals, apparent electro-chemical protection being observed in some cases. The phenomena were best explained by the assumption that electro-chemical action occurred in the adherent—usually invisible—film of moisture. Volatile electrolytes increased the conductivity of the film and thus accelerated corrosion. Where they tended to produce hygroscopic corrosion-products, they brought about the absorption of further moisture and thus increased the thickness of the film; in several cases—zinc in hydrogen chloride, copper in ammonia, nickel in sulphur dioxide—the metal, originally dry, soon began to shed liquid copiously, and in such cases corrosion was very serious. The experiments described were carried out in the Goldsmith Laboratory, Cambridge.

Stainless Silver.

Mr. Orme gave the results of tests on alloys used in the manufacture of spoons and forks in Sheffield. One of these was the so-called stainless alloy containing 64 per cent. copper, 35 per cent. nickel, and 1 per cent. tin; another the non-corrodible alloy with 60 per cent. copper and 40 per cent. nickel; and a third the standard spoon and fork alloy containing 56 per cent. of copper, 30 per cent. of zinc, and 14 per cent. of nickel. The results of the experiments showed very clearly the applications of these alloys, and indicated that in some respects the ordinary nickel silver alloy was the more resistant to corrosion.

Mr. Harold Turner gave an account of work in progress in the production of an alloy resistant to corrosion, which was to be introduced into the sterling silver trade. Attempts had, he said, been made for some time past to produce an alloy which would resist atmospheric influences. The difficulty in this case was that the field of the experimenter was severely restricted by the fact that to obtain the hall mark the alloy had to contain 92½ per cent. of silver, leaving only a range of 7½ per cent. in which to make variations in composition. Although he was unable for various reasons to give full details of the work, he was able to say that a considerable amount of progress had been made in the production of stainless silver by those engaged in the industry, and they hoped to put on the market an article which would obviate the weekly labour involved in polishing. It was a remarkable fact that the ordinary silver copper alloy had been worked almost unchanged since the fifteenth century. He had had samples made of the new alloy, which had stood for two years without cleaning, and it was felt that the time had come when articles made from the new alloy could be put on the market.

Australian Engineering Notes.

In Queensland, in the region of Gympie, a belt of country near the Great Northern Extended Mine, is to be tested to see whether gold exists. The Deputy Chief Government Geologist of Queensland advocates the prospecting of the known limestone strata by means of a diamond drill, and considers that the deeper ground in this portion of the State may well prove to be wealth producing.

* * * * * *

Discussing oil developments in Queensland, the Minister for Mines stated recently that 1923 was pregnant with possibilities. He hinted that the Government, which lately abandoned operations in the Roma bore, might make other attempts to discover payable fuel oil, and said that parties were at work between Brisbane and Gympie, and Roma and Injun Creek. The Minister said that the Government would introduce legislation to encourage prospecting for oil on sound geological lines, while safeguarding the interests of the State by imposing royalties. He advocated legislation restricting the granting of oil prospecting licences or leases, and permitting the issue of a prospectus only when backed by reasonable geological opinions. The Elcho Island Naphtha Petroleum N.L., of Melbourne, has appointed as engineer, Mr. E. T. Zakharov, who will make a survey of the property before sinking the bore. The plant for surveying purposes will shortly be purchased by the Board. The engineer is hopeful of oil being encountered at a shallow depth. It is likely that boring for oil will be undertaken soon in the shire of Woorayl, in Gippsland (Vic.), where the existence has been proved of definite traces of crude petroleum. Oil shale production in New South Wales in 1922 declined 9022 tons, as compared with the previous twelve months, when 32,489 tons were raised. Practically the whole of the output came from the Commonwealth Oil Corporation's property at Newnes, and as these mines have lately been closed down, the outlook for the current year is not considered promising.

* * * * * *

The Brisbane Metropolitan Water Supply and Sewerage Board has decided to construct a weir across the Brisbane River, and to lay a two miles length of conduit. It is estimated that the weir will cost £52,000, and the conduit between £25,000 and £35,000. It has also been decided, on the recommendations of the engineer, Mr. A. J. Gibson, to install two rapid sand (mechanical) filters.

* * * * * *

Tenders will be received until June 13th, 1923, by the Chief Electrical Engineer, New South Wales Railways, 61, Hunter-street, Sydney, for the supply of two 20,000-kilowatt, 50-cycle, 11,000-volt turbo-alternators for the White Bay power-house.

* * * * * *

In an attempt to capture the coal markets of the East, the Queensland Government intends to equip the State coal mine at Bowen with electric light, electric coal cutters and electric locomotives.

* * * * * *

The electric supply undertaking of the Melbourne City Council for the year ended December 31st, 1922, showed a gross profit of £160,124, or an increase of £58,333 over the year 1921. The Council decided to reduce, as from April 1st, the price per unit of electric current used for manufactures other than for lighting by three-tenths of a penny per unit, and to reduce by a farthing per unit power for lighting purposes. The Electric Light Committee has recommended a reduction of 20 per cent. on the hire charges for electric motors.

* * * * * *

A conference of delegates from all the local governing bodies in the northern districts of New South Wales, recently held at Armidale, decided to form a county council in order to undertake hydro-electric and railway development schemes.

* * * * * *

The Wellington, N.Z., Chamber of Commerce has urged the Government to postpone the lifting of the embargo on trade with Germany until January next, on the ground that merchants have already ordered goods for next Christmas trade, and great loss will be entailed if German manufactures are allowed to enter the country before then.

* * * * * *

A Sydney firm has decided to establish an oil works in Victoria, and has secured five acres of land near Melbourne. At the outset employment will be found for about one hundred men. The works will be in charge of an Englishman with long experience in the trade.

* * * * * *

The Victorian Electricity Commission is inviting tenders, closing on August 31st, for the supply of five hundred miles of aluminium steel-cored cable with a cross-section area of .0707 square inch.

* * * * * *

Consequent upon the Sydney City Council's adoption of a policy of absolute Empire preference, the Electricity Committee has recommended the rejection of a Japanese tender of £687 for the supply of 2500 disc strain insulators in favour of a Canadian tender of £1562.

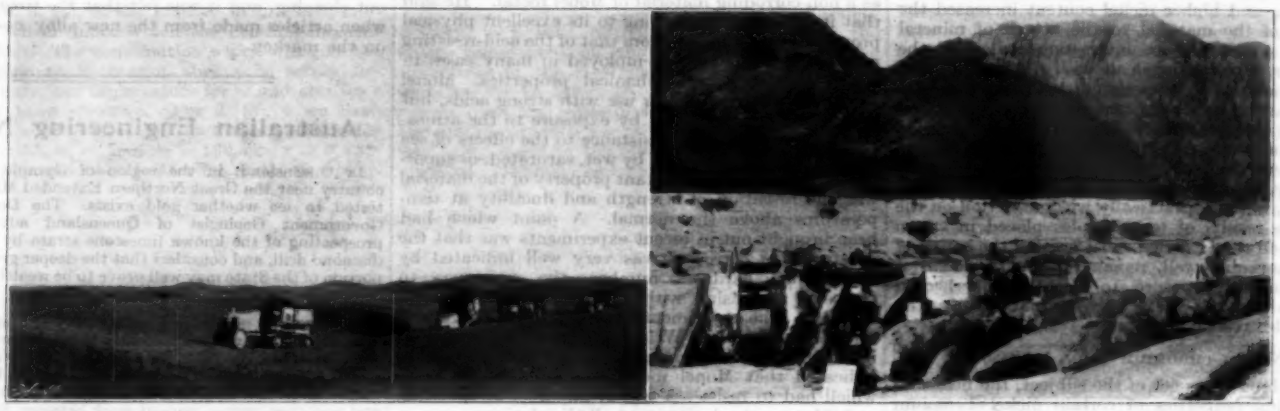
Crossing the Sahara by Motor Car.

NOTWITHSTANDING their shortcomings, in certain directions the usual forms of caterpillar tracks are rendering real service in conditions in which ordinary wheeled vehicles cannot be used, and for military purposes their advantages have been amply demonstrated. They are not, however, by any means suited to all kinds of work. The problem of how best to make the endless track system capable of more general application than it then was, was taken up about thirteen years ago by a French engineer, M. Kégresse, who was in charge of the Imperial Automobile Service in Russia until the time of the revolution in 1917, during which period he obtained satisfactory results with a system of rubber track, which permitted of motor cars travelling over the snow at not much less than ordinary touring speeds. On returning to France M. Kégresse associated himself with M. André Citroën, and during the past two or three years a series of demonstrations have been carried out with the Kégresse tracks on Citroën cars, travelling in winter over snow-bound mountain roads, and in summer proving the possibility of traction over marsh lands and even showing that speed and steering compared favourably with those of wheeled touring vehicles on the road.

Having done all that was possible to demonstrate the efficiency of the system in France, M. Citroën conceived the idea of sending a number of cars across the Sahara Desert. The question of opening up rapid communication between North Africa and the Niger Valley has been growing in importance during the past few years on account of the programme which has been initiated by the State of developing the resources of West Africa and supplying the Mother Country with practically everything she needs in the way of cotton, oil, rubber, and other products. Whether or not any of the schemes for constructing railways across the desert are likely to materialise, they certainly cannot be put into execution for a long time to come, and until the Citroën cars traversed the desert, there was no means of transport other than that provided by camel caravans. The character of the country precludes the use of any kind of wheeled vehicle. There are vast sandy regions—see Fig. 1—alternating with nullahs, or dry beds of ancient rivers many miles wide, which are followed by caravans because they offer the only possibility of finding water in wells at long intervals, usually 50 miles or more from each other. Some of the wells are periodically dry and are sometimes brackish, and over one part of the desert there is no water available for 300 miles. The nullahs are strewn with stones and huge boulders—see Fig. 2—and then the caravans traverse a vast rocky any stony region, with occasional mountain ranges. This inhospitable country seemed to offer insuperable difficulties to any kind of vehicular transport, but M. Citroën believed that the Kégresse system of propulsion would vanquish all obstacles and open up a route of communication. The undertaking entailed an elaborate organisation in the way of establishing stores of petrol along the route by means of two groups of cars, one going north from Timbuctoo and the other south from Touggourt. On account of the predatory character of some of the tribes, one of the vehicles on this journey of 3270 kiloms., or nearly 2050 miles, from Touggourt to Timbuctoo, was equipped with machine guns.

Starting on December 17th last year the four cars—views of two of which are given in Figs. 3 and 4—arrived at Timbuctoo on January 7th, the route taken being that shown on Fig. 5—and after staying a month on the Niger they left for the return journey on February 9th, and reached Touggourt on March 6th, the vehicles continuing to Algiers, where they embarked for Marseilles, and were then run to Paris. The weight of each vehicle in running order was about 2300 kilos.—just over 2¼ tons. The cars travelled at an average speed of from 9 to 11 miles an hour, while the consumption of petrol is said to have been less than 27 litres, or nearly 6 gallons per 100 kiloms., or, say, 62 miles, and of lubricating oil for the same distance 1¾ pints. The whole journey appears to have been accomplished without incident. For the first time motor cars traversed a vast waterless region in which immense sand dunes and dry rocky beds appeared to exclude all forms of transport other than camel caravans, and the experiment has opened up a new development in motor traction, not only in North Africa, but in other parts of the world as well.

That result has been made possible by reason of the endless rubber tracks with which the cars were equipped, and which possesses great flexibility, so that they "give" to surface irregularities with the same facility as the pneumatic tire will roll over smaller asperities. The band which forms the track, and a small section of which is given in Fig. 6, is composed of a rubber fabric like the outer covering of a pneumatic tire. It has a base with peripheral and transverse thickenings on the outside for increasing road adherence, while on the inside of this flat base is a triangular projection in which slots are formed to permit of the band rolling round the pulleys. The serrated driving band runs in grooves on the pulleys, thereby providing the necessary friction for propulsion, and the bearing rollers—lettered E in Figs. 7, 8 and 9—run on the flat plates or flanges of the track on each side of the driving band. In order to obtain absolute flexibility, the chassis carrying the track had to be designed to ensure free movements of all the parts around one axis. That axis, which is seen at B in Figs. 7 and 8, is fixed to the car frame. Above and below the axis, and pivoting on it, are the springs



FIGS. 1 AND 2—TYPES OF COUNTRY TRAVERSED BY THE CARS

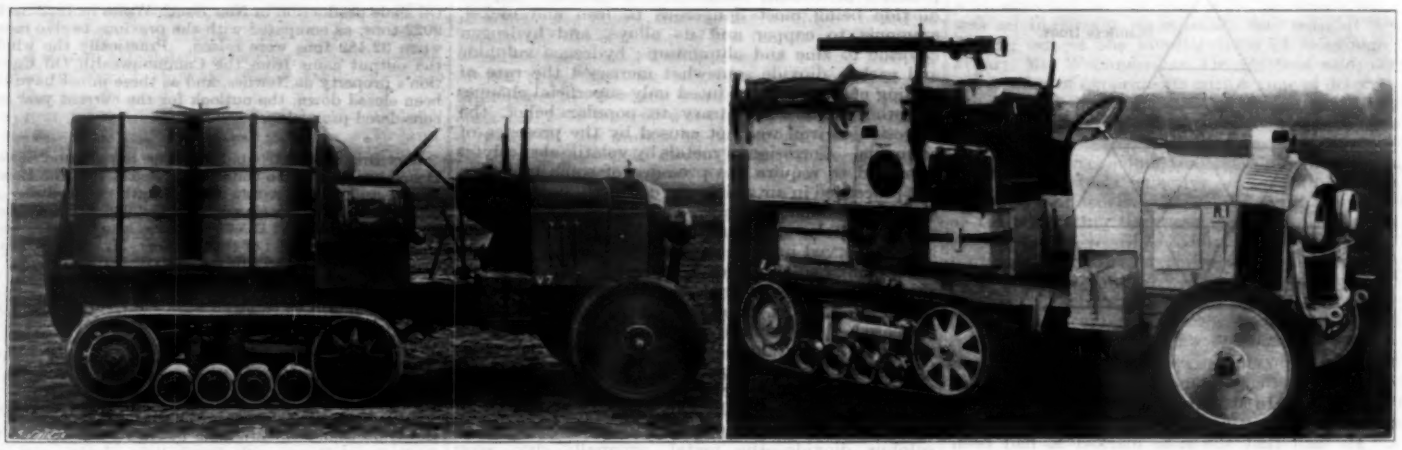


FIG. 3—CAR CARRYING STORES OF PETROL

FIG. 4—CAR EQUIPPED WITH MACHINE GUN

FIG. 5—ROUTE TRAVERSED BY THE CARS

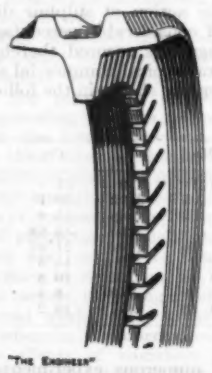


FIG. 6—SECTION OF KEGRESSE RUBBER TRACK

C C, of which the ends are connected by the links D D extending downwards and carrying the articulations of the rollers. The arrangement is shown diagramatically in Fig. 9, which, together with Fig. 7, are reproduced from an article in our contemporary, *Le Génie Civil*. The driving pulley A is composed of two halves, the outer half being fixed on the end of the differential shaft and the inner half turning with it through the medium of a cam arrangement, so that with the increasing driving effort the two halves

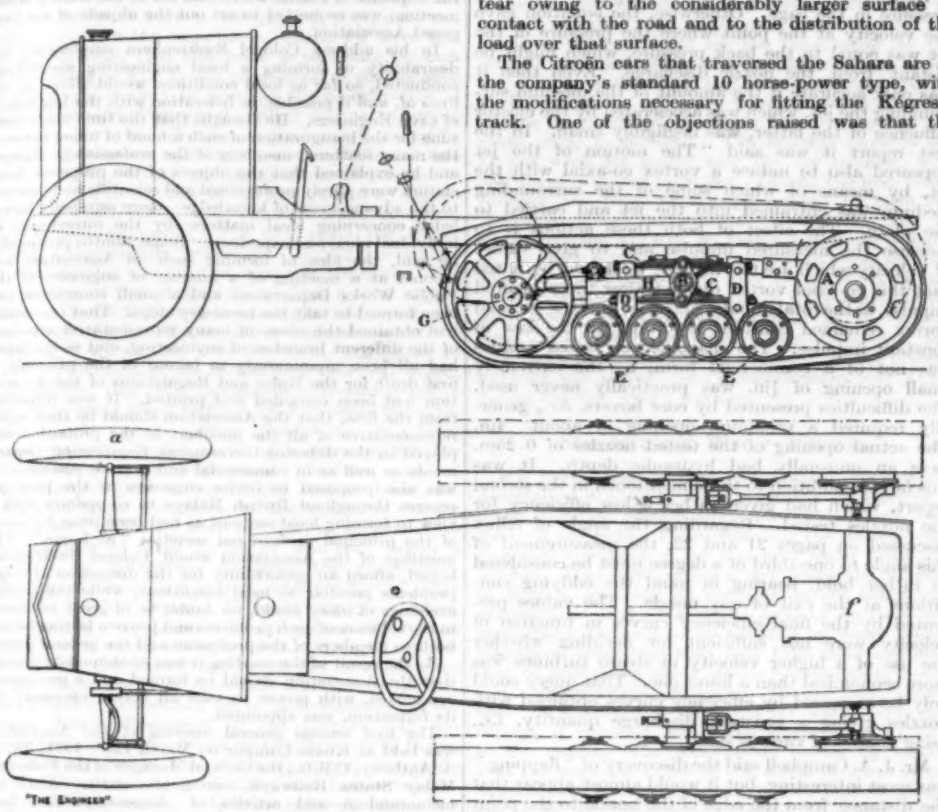


FIG. 7—CHASSIS OF CITROEN CAR FITTED WITH KEGRESSE FLEXIBLE TRACK

are drawn closer together and exert a greater grip on the band. There is no spring between the differential shaft and the car frame, the shaft being retained simply by leather straps to check any excessive relative displacement. While the grip on the driving band is proportionate to the tractive effort, means of regulating the tension on the track are provided by the rod H with worm shaft adjusting the distance of the loose pulley F from the axis B. There is also a swivel tension rod between the axis and the driving

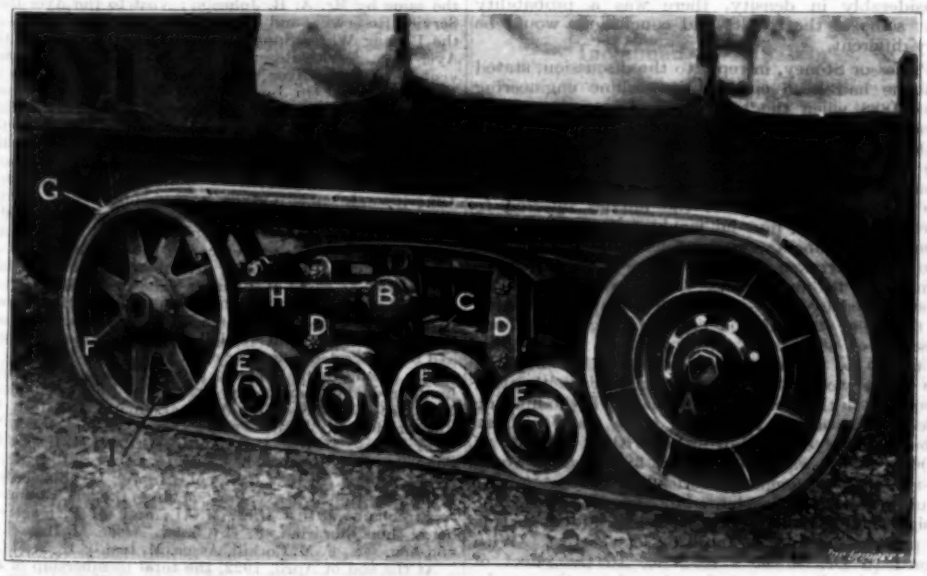


FIG. 8—VIEW OF ENDLESS TRACK AND BEARING ROLLERS

pulley. As the track chassis pivots around the axis, the pulley F has a considerable vertical displacement, and can ride over any obstacle, and each pair of rollers being independent the track will follow the sinuosities within limits without causing shocks or vibration to the vehicle.

The makers assert that the frictional losses of such a device are far less than with articulated metal plates, and bring forward in proof of the assertion the silent running of the cars and the high speeds attained. The speed on ordinary roads is said to be about 30 per cent. less than with the same vehicle on pneumatic tired wheels. The fear that a rubber fabric would rapidly deteriorate is dispelled by its proved durability during the experiments of the past three or four years, while its resistance in the Sahara Desert, where it was subjected to extremely high temperatures and to the abrasive action of the sand, leave no doubt that the rubber track may be regarded as no less durable than the pneumatic tire. As a matter of fact, it is subjected to far less wear and tear owing to the considerably larger surface in contact with the road and to the distribution of the load over that surface.

The Citroën cars that traversed the Sahara are of the company's standard 10 horse-power type, with the modifications necessary for fitting the Kégresse track. One of the objections raised was that the engines would be liable to suffer in a country where a penetrating and impalpable sand is driven across the desert by occasional storms. Before undertaking the journey, however, similar cars had travelled thousands of miles in the desert with a view of prospecting routes and ascertaining if the scheme were practicable, and on analysing the oil in the crank chambers there was no trace of sand to be found. The usual type of radiator was fitted, but of larger capacity, and despite the high temperatures, it is declared that the water never reached boiling point. The differential is provided with a double reduction gear, so that with the three-speed gear-box there are six changes of speed from 3 kiloms. to 40 kiloms. an hour. Normally the steering is effected by the front wheels in the usual way, but as a difference in road friction may cause one track to creep more than another, the driver must be able to lock the differential in case of emergency. For the same reason brakes are fitted on the drums of the driving pulleys, and are actuated by cables from the steering column. By braking the tracks the car will turn almost in its own length. The track described is stated to be capable of riding over obstacles 12in. or 16in. high, and for heavier vehicles which have to surmount obstacles 3ft. high, a modified form of track is provided. As a matter of fact, less attention is paid to the fitting of light cars with the Kégresse track than to its application to military and other heavy vehicles, which have given very good results for haulage purposes and for travelling cross country. The advantages claimed are that the vehicles travel at much higher speeds than are possible with articulated metal shoes, the rubber bands last much longer, and they do not deteriorate the roads. Nevertheless, recent experiments have shown that even light cars with Kégresse tracks are capable of rendering

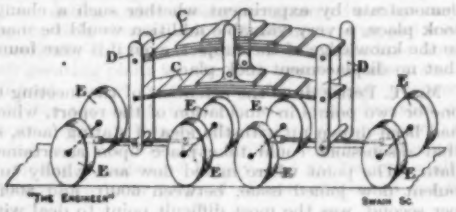


FIG. 9—ARRANGEMENT OF SPRINGS AND BEARING ROLLERS

excellent service in conditions in which other types of vehicles cannot be used, and as a result of the Sahara journey, arrangements are already being made for establishing services in the desert to the south of Algeria, and, doubtless, the system will find application in other parts of Africa.

Steam Nozzle Research.

At a meeting of the North-Western Branch of the Institution of Mechanical Engineers held on Thursday, 12th inst., Professor Stoney read an abstract of the report of the Steam Nozzle Research Committee. The reading was followed by a good discussion, in which several members took part.

Mr. Chittenden observed that the curves published proved fairly conclusively that the modern tendency to reduce the number of stages and increase diameters was correct. In the past there had been two schools on this subject—the American school, which favoured a large number of stages of small diameters, and the continental school, which preferred few stages and large diameters. He considered the pitch of the nozzles which were tested too small, and if it had been increased higher efficiencies would have been obtained, and there would not have been quite the same difference between the curve No. 1 and the remaining curves. His company, he added, was working with nozzles with wider pitches and would be in a position to check the effect of increasing the pitch. He suggested that on the same apparatus should be tested the effect of the finish of the surface.

Mr. Bauman agreed with the first speaker that the tests were of very great value to turbine industry. Professor Stoney had shown curves which had not been published, showing the big discrepancies which existed amongst results. When the tests were finished those discrepancies would be cleared up, and the turbine designer in future would have some definite basis on which to work.

Mr. Guy said that one of the first considerations which arose, and which was dealt with in the report, was to be quite sure that there was no possibility of a false reading on the pressure plate, used to measure the reaction, and that all the energy of efflux was converted to pressure energy on it. The committee therefore carried out an experiment in which it was demonstrated that under the conditions of this experiment no such error occurred. Whilst he did did not think that in the actual apparatus as used in Manchester there was any reasonable possibility that an error of that character could arise, he thought it would be worth while if the experiments were repeated, using the casing which was actually used in the nozzle experiments, because in the reaction experiments a box was used of different dimensions from the casing employed in the nozzle experiments. The character of the velocity coefficient curve which was contained in the report was of peculiar interest, but from the results given in the report he did not think it could be taken that the nozzle efficiency necessarily increased as the velocities were increased above a certain velocity, relatively to the velocity coefficient obtained at lower velocities. An examination of the curves in Fig. 1 would bear that out. It would be seen in curve 4 that the coefficients round about 1200ft. per second were as high as those at 1900ft. per second, and the coefficient at 400ft. per second was still higher, but apart from that, in the question of the desirability of adopting relatively large or small number of stages in a turbine, it should be remembered that nozzle efficiency was only one of the factors, and the range of possible variation was very small compared with the range of variation in the ten other factors which entered into the balance sheet. With regard to the character of this curve, it was somewhat doubtful whether it could be assumed that its position relative to the velocity base neces-

arily remained the same throughout the whole range of steam conditions. In a turbine, at the higher pressure end, there might be velocities of 1200, and a pressure of up to 200 lb. per square inch, whereas at the exhaust end the pressure might be only 1 lb. per square inch. One knew that velocity varied under those conditions, and he wondered whether the point on the velocity coefficiency curve was not really a function of the conditions which existed at critical velocities, rather than a function of the absolute magnitude of that velocity. The change-over point from viscous flow to turbulent flow would vary with temperature and pressure conditions. If that were so one might have, for instance, three such curves displayed laterally, one applying to conditions at the high-pressure end, one to the middle, and one to the exhaust end. If the committee could demonstrate by experiment whether such a change took place, a very valuable addition would be made to the knowledge of the subject, even if it were found that no displacement took place.

Mr. T. Petrie drew the attention of the meeting to one or two points in elucidation of the report, which had been drawn up with the idea of stating facts, so that discussions could take place upon ascertained data. The point where mixed flow and wholly turbulent flow joined issue, between 600ft. and 800ft. per second, was the most difficult point to deal with in the whole run of the experiments. At that point less consistent results were obtained, and in one or two cases it had been difficult to join up mixed flow with wholly turbulent flow. It was evident that something of an unusual nature happened at that point. That conclusion was borne out by some analyses made by research students on the work. One showed that between 600ft. and 800ft. per second the discharge coefficient became a minimum, and another showed that it was at about that point that the *vena contracta* was formed in the nozzle. Speaking of the preliminary curves for efflux angles given in the first report—page 21, Fig. 12—Mr. Petrie said that work had been completed long before the work included in the second report, and he wished to emphasise the fact that the results did not represent the mean efflux angles of the steam as it left the nozzles, but the efflux angle as the committee wanted it, some 2½in. away from the face of the nozzle.

Dr. Morley said it seemed desirable that experiments should be repeated if possible at various pressure ranges, as it was quite possible that the results obtained at a certain velocity with one pressure would not be the same as those obtained with a different pressure. He also suggested that a further check test should be made with the impact apparatus to see whether any difference would be caused by varying the distance from the nozzle box to the impact plate. His reason for making that suggestion was that, particularly after the critical point was reached, there would be standing waves of pressure, and it was quite clear that the result obtained would be entirely dependent upon the particular phase at which the plate was placed—at the crest of the wave one result would be obtained, while probably the result at the hollow would be very different. With reference to the apparatus, the engineering world was indebted to Mr. H. F. Martin, and his name should be associated with the work of the committee, both for his skill in designing the apparatus and for the great ability he displayed in discussing the theoretical aspects in explanation of the variation in the coefficients obtained. The speaker had experienced the same difficulty referred to in the report in the method of determining the velocity by the impact on the plate, and had obtained different results with the plate at different distances from the nozzle, but for a reason wholly different from that already mentioned. He had also obtained results which apparently indicated a much higher velocity than those obtained by the reaction method. In his paper of 1916, he had attempted to give an explanation of this fact, which was accepted by Mr. Martin, and was partly responsible for the design of apparatus he adopted. The theory was that the jet issuing from the nozzle was not the only fluid which struck the impact plate. There was set up round about the jet a circulation of air, and the fluid deflected by the plate was not only the original jet, but also some of this circulating air. Mr. Martin's design of the cage was intended to ensure that whatever change of direction took place in the circulating fluid from a motion parallel with the jet to a motion along the plate should be balanced by an effect due to the other changes of direction of the circulating air. For that reason he adopted the cage with a series of rings, forming parallel discs, so that the air had to enter at right angles, and also that the air thus entering was caught upon the top plate before turning and following the direction of the jet. For that reason, Dr. Morley asked if, in the present design of the apparatus, there was a top plate on the nozzle box, as it was hardly consistent to use the rings at all unless they were combined with the top plate. By adopting wire gauze on the plate, the Committee had also endeavoured to ensure that whatever circulation of air or other fluid there was should be associated with the jet at extremely low velocities.

Mr. Konig congratulated the committee on having eliminated for the first time by its ingonious cage arrangement the discrepancies between impulse and reaction tests. Attention, should, however, be drawn to the suggestion of Professor Stodola in his fifth edition—page 57—where he proposed a cage in principle equivalent to that used by the Research Committee. When considering the fundamental equation on page 4 of the first report, $C_v = \frac{F.g.}{m}$, it was to be borne in mind that that equation gave the velocity in the discharge area of the nozzle only if the pressure at that point was equal to the back pressure in the cage. Otherwise, the equation gave the velocity at the point where the pressure of the jet was equal to the back pressure, which might be distant from the nozzle discharge. Even then it was only accurate if the amount of the medium surrounding the jet, which was accelerated by the ejector influence of the latter, was negligibly small. In the first report it was said "The motion of the jet appeared also to induce a vortex co-axial with the jet, by means of which some of the surrounding medium was entrained into the jet and carried to the plate. The effect of both these actions is to increase the measured impulse and to give values of velocity which are too high." It should be noted that this co-axial vortex did not alter the measured impulse, as the total impulse of the jet plus the co-axial vortex remained constant according to the law of constant impulse. The shape of the tested nozzles was not of a commercial form, as the extremely small opening of ¼in. was practically never used. The difficulties presented by core boxers, &c., generally required a minimum opening of about .4in. The actual opening of the tested nozzles of 0.25in. gave an unusually bad hydraulic depth. It was this fact, in addition to those mentioned in the second report, which had given rather a low efficiency for the nozzles tested. Regarding the angle of efflux discussed on pages 21 and 22, the measurement of this angle to one-third of a degree must be considered as rather bold, bearing in mind the eddying conditions at the exit of any nozzle. The values presented by the final efficiency curves in function of velocity were not sufficient for deciding whether the use of a higher velocity in steam turbines was more economical than a lower one. That query could only be answered by efficiency curves obtained with nozzles giving a constant discharge quantity, *i.e.*, using nozzles of various sizes.

Mr. J. A. Campbell said the discovery of "flapping" was most interesting, but it would almost appear that the distance from the edge of the nozzle to the point at which any material change of angle took place was greater than anything worked to in practice. In Tables I., II., III., IV. and V., giving the results of the tests for velocity coefficient, there were one or two features which were worthy of note. In many cases where two tests or more had been carried out with practically the same initial and final pressure but with varying superheat, the velocity coefficient obtained with the higher superheat was in most cases lower than that with the lower superheat. That seemed to be rather at variance with the usual beliefs. The reasons given for the adoption of superheat for these tests of such a degree that would ensure a condition of superheat at the exit of the nozzle, were quite good, but where the final pressures varied considerably in density, there was a probability that some of the results and conclusions would be very different.

Professor Stoney, in reply to the discussion, stated that he had been engaged in turbine engineering since 1888, when the biggest turbine made was 50 horse-power, and it had always been his wish to undertake research work which would be useful to the turbine industry. Referring to Mr. Chittenden's remarks, Professor Stoney stated that as soon as the necessary drawings of the nozzles referred to were received by him he would be willing to test them. Experiments on the finish of nozzles could also be undertaken, and it was the intention of the committee to make tests with various pressures, as suggested by Mr. Guy. With the apparatus used in the tests it would be possible to go to a back pressure of 60 lb. and initial pressure of anything up to 200 lb. He agreed with Mr. Guy that probably the curve would shift to the right or to the left, according to the steam pressure used. If the limiting velocity was about 2100ft., in these tests this was about 38 per cent. above the critical velocity of 1600ft., and it was believed that 38 per cent. would be true right through the series. If that was so, it would mean that the plan adopted by steam turbine designers of calculating theoretically and deducting 10 per cent. would be more or less correct. With regard to Dr. Morley's reference to the effect of varying the distance of the plate from the nozzle, that had been tried but was found to have no effect. Undoubtedly there were standing waves of pressure which might be found to have effect after the critical point had been reached. Vibration only occurred when using a spring balance. When that had been done away with and the impulse was taken by dead weights, the momentum had been sufficient to eliminate vibration. A test generally took from two to three weeks, although, of course, the apparatus had to be run for a while to get everything thoroughly warmed up.

The Engineering Association of Malaya.

We have received a copy of Volume No. I. of the "Transactions" of the Engineering Association of Malaya. This institution was brought into being at a meeting held at Kuala Lumpur on March 14th, 1920, at which Mr. A. MacLennan took the chair, and at which Colonel Swettenham, as having been intimately connected with the sequence of events which had led to the calling of the meeting, was requested to set out the objects of the proposed Association.

In his address Colonel Swettenham emphasised the desirability of forming a local engineering association, conducted, so far as local conditions would allow, on the lines of, and if possible, in federation with the Institution of Civil Engineers. He thought that the time was opportune for the inauguration of such a bond of union between the many scattered members of the profession in Malaya, and he explained that the objects of the proposed Association were purely professional and scientific and devoted to the advancement of knowledge—more especially knowledge concerning local matters—by the interchange of individual ideas and experience. Some months previously, he said, the idea of forming such an Association was mooted at a meeting of a number of engineers of the Public Works Department and a small committee had been formed to take the necessary steps. That committee had obtained the views of many representative members of the different branches of engineering, and as the latter had all been unanimously in favour of the principle, a first draft for the Rules and Regulations of the Association had been compiled and printed. It was intended, from the first, that the Association should be thoroughly representative of all the members of the profession employed in the different Government Engineering Departments as well as in commercial and private practice. It was also proposed to invite engineers in the principal centres throughout British Malaya to co-operate with a view to forming local sections as had been done by many of the principal professional societies "at home." The meetings of the Association would, Colonel Swettenham hoped, afford an opportunity for the discussion of many problems peculiar to local conditions, while the mutual exchange of ideas would, no doubt, be of great assistance in the solution of such problems and prove a lasting benefit both to members of the profession and the general public.

As the result of the meeting it was unanimously decided that the Association should be formed and a provisional committee, with power to take all action necessary for its formation, was appointed.

The first annual general meeting of the Association was held at Kuala Lumpur on March 13th, 1921, Mr. P. A. Anthony, C.M.G., the General Manager of the Federated Malay States Railways, taking the chair. After the memorandum and articles of Association had been approved, the following officers for the year were elected:—President, Mr. P. A. Anthony; Vice-presidents, Messrs. A. MacLennan, J. Fettes and G. Forbes; hon. sec. (*pro tem.*), Mr. F. M. Corkill; member of Council, Messrs. A. H. Alston, E. L. Bennett, J. Craig, A. H. Flowerdew, F. D. B. Openshaw, H. Robinson, J. Strachan and W. A. Wilkinson. On the resignation of Mr. P. A. Anthony on January 8th, 1922, on his going on leave, the Council elected Mr. A. MacLennan to fill the office of President.

It was decided to hold meetings quarterly, and the following meetings were held:—June 10th and 11th, 1921, lecture, "Modern Town Planning," by Mr. C. C. Reade, A.T.P.I., and visit to Anti-Malarial Works at Kuala Lumpur. September 23rd and 24th, 1921, visit to Bukit Serayeh Reservoir, and paper by Mr. D. W. Brisbane on the "Prai Water Supply Scheme"; visit to the Penang Hills Railway Construction Works, and paper on the same by Mr. A. R. Johnson; visit to the Ayer Itam Service Reservoir, and a paper entitled "Some Notes on the Penang Water Supply, with special reference to the Ayer Itam Service Reservoir," by Mr. J. D. Fettes; and visit to the Prai River Wharves, and a paper on them by Mr. J. Brown. On January 7th, 1922, visits were paid to the F.M.S. Railway's central workshops, to the Batu Caves quarry and Portland cement works, and to the concrete works of Messrs. Kennisson Bros., while on the next day a paper entitled "Deterioration of Structures in Sea Water," by Mr. M. F. G. Wilson, was considered. The papers, taken as a whole, were of considerable interest—the majority being commendably short and most suitable for discussion—while the diagrams which accompanied them, and which are reproduced in the volume before us, are excellent. The average attendance at the meetings is reported as being over sixty. The financial condition of the Association at the end of the year 1921 was very sound. Out of a total income of 5183 dollars, there was a surplus balance of 4113 dollars, 2500 dollars of which had been invested in a 7 per cent. loan.

The second annual general meeting was held at Kuala Lumpur on February 26th, 1922. The following officers were elected:—President, A. MacLennan, M.I. Mech. E.; Vice-presidents, J. D. Fettes, Assoc. M. Inst. C.E., W. Eyre Kenny, M. Inst. C.E., and J. Brown, M. Inst. C.E.; Council:—E. L. Bennett, Assoc. M. Inst. C.E., J. Craig, F. D. Evans, Assoc. M. Inst. C.E., M.C.I., A. H. Flowerdew, F.G.S., the Hon. J. H. W. Park, M. Inst. C.E., H. Robinson, J. Strachan, M. Inst. C.E., M.C.I., and J. P. Swettenham; hon. librarian, F. C. Coales, Assoc. M. Inst. C.E.; and hon. sec., F. M. Corkill, Assoc. M. Inst. C.E., A.M.C.I.

At the end of April, 1922, the total membership of the Association numbered 176, made up of 8 Honorary Members, 163 Members, and 5 Associates. The names of the Honorary Members were: R. O. N. Anderson, Assoc. M. Inst. C.E., L. M. Bell, M. Inst. C.E., F. St. G. Caulfield, M. Inst. C.E., H. Gittins, Sir John R. Nicholson, R. M. Peirce, J. Trump, and M. Fitz.-G. Wilson.

Notice has been given by the Railway Rates Tribunal that in connection with the schedule of proposed standard charges, the companies have submitted their proposals for mileage gradations for the conveyance of coal, coke and patent fuel. Copies of these may be obtained, price 1d., from the Railway Clearing House.

A Seven-Day Journal.

The Conjoint Board of Scientific Societies.

THE report issued this week by the Conjoint Board of Scientific Societies on its work and finances since its foundation in 1916 to the present year, does not help to remove the impression, which we have had for a long time, that this body is perishing for lack of something to do. It was established at the instance of the Royal Society to promote the co-operation of those interested in pure and applied science, to supply a means for the effective expression of scientific opinion on matters relating to science, industry and education, to further the application of science to industry and the service of the nation, and to discuss scientific questions in which international co-operation seemed advisable. For two years the Board issued a fortnightly statement, giving particulars of forthcoming meetings of scientific societies. The publication of that statement involved a total expenditure of some £527 and has now been dropped. It has compiled a list of scientific periodicals and of the libraries in which they may be found, and hopes to have it published in the course of a year. It urged, ineffectively, that the Government should grant a site for housing allied technological societies in juxtaposition. It passed various resolutions on educational matters, busied itself with schemes for the establishment of a geophysical institute, and of an anthropological survey of the British Isles, investigated some anomalies in the magnetic survey and showed that they were not due, as suggested, to the existence of large bodies of iron ore; began a research on adhesives, discussed the compulsory adoption of the metric system, and conducted other business of a like nature. The only respects in which its activities may be said to have been other than minor and of small value, were in the slight connection which the Board had with the establishment of the Department of Scientific and Industrial Research and in the setting up of its Committee on the Water Power Resources of the Empire. It has doubtlessly been hampered by insufficiency of funds, but it is significant that when an appeal was made to the Department of Scientific and Industrial Research for assistance, help was refused, while the number and annual subscriptions of the societies supporting the Board are showing a rapid decline.

A Catalogue of Old Mathematical Works

WE have been browsing over a catalogue of mathematical works, mostly rare and of historical importance, which Messrs. Sotheran, the well-known booksellers of the Strand and Piccadilly, have sent us. Those acquainted already with the catalogues issued by this firm will not require to be told that the work is very full of historical, literary and scientificinterest, for it is Messrs. Sotheran's pleasant custom to annotate their lists in an engaging and scholarly manner. The chief impression which dominates our mind after studying the catalogue is the relatively low price sought for some very rare, ancient works on mathematics. Take the "Geometria Speculativa" of Thomas Bradwardine, fifty-third Archbishop of Canterbury, who exhorted the troops on the eve of the Battle of Crecy and died, a martyr to duty, from the Black Death. This work, published in 1511, although it contains but twenty pages, seems cheap at eight guineas. An even better bargain would appear to be Piero Borgi's "Libro de Abacho," a work of one hundred pages, published in Venice in 1509, which may now be purchased for the modest sum of four guineas. Perhaps the greatest surprise is a copy of the first Latin edition of Euclid's Elements, a work translated, either from the Greek original or from an Arabic version, by Adelard, of Bath, and published at Venice in 1482. This was the first printed book on mathematics, and the first having geometrical diagrams. Yet Messrs. Sotheran are prepared to sell a copy of it for £27 10s. From a list of "Desiderata" enclosed with the catalogue, we gather that we ourselves are becoming old enough to have an interest for the antiquarian—at least as regards our issues of 1856–61.

Unemployment Insurance by Industries.

A REPORT just issued by the Ministry of Labour on the administration of Section 18 of the Unemployment Insurance Act, 1920, covers a statement of the statutory provisions now governing insurance against unemployment "by industries," an account of the action taken to give effect to Section 18 of the Act, and a discussion of how the scheme might be developed. The only section of the community among which a scheme of unemployment insurance by industries prevails at present, fittingly enough, embraces those employed in the insurance business. Details of the working of the scheme adopted in this instance are given in an appendix to the report, and present an interesting picture of how the idea works out in practice. The scheme was established under Section 18 of the Act and came into operation at the beginning of July, 1921. It covers about 85,000 persons, among whom are the employees of all life and general insurance offices in the kingdom, friendly societies, such bodies as the Manchester Steam Users' Association and certain employees of trades' unions. The employers' contributions are equal to those in force for the time being for the general scheme under the Insurance Acts, while the employees normally pay no contribution except in the event of a deficiency being disclosed after the scheme has been in operation for seven years. A State grant is received. The benefits payable are £1 per week for males and 16s. for females, with half these rates for juveniles. During the first year's working the total receipts amounted to £236,382. The expenditure on benefits was £31,651, and on administration £17,672, so that a handsome balance on the right side amounting to £187,059 was secured. The State contribution, it may be noted, is limited by the 1920 Act to a maximum of three-tenths of the sum which would have been paid as the State's share under the general provisions of the Act, had there been no special scheme in force. In the present instance the Government's contribution was £8800 during the first year's working.

Standardised Water Fittings.

WE have received from the British Waterworks Association a circular letter in which an attempt is made to refute certain allegations which have been made in the public Press regarding the Association's proposed specification for standard water pipes and fittings. That specification is now before the Ministry of Health, awaiting its sanction before being promulgated as part of a model code of by-laws and regulations designed to be adopted by water undertakings in order that they may fulfil their statutory duty of preventing waste, undue consumption, misuse and contamination of water. It has been alleged that the standard specification for water pipes and fittings, if enforced, will entail unnecessary expense to the public. The Association replies by stating that the principal cause of the waste of water is the existence of faulty fittings in houses and buildings, and that its specification merely lays down such minimum requirements for the manufacture of these fittings as will secure to the public an efficient article at a minimum cost. The letter disclaims the Association's intention to interfere with fittings already in use, and states that the new specification will only apply to fittings for new buildings or new fittings installed in place of old. While we readily grant that some control over the quality of the fittings is necessary, we would urge that it ought to be applied intelligently, and not, as at present, in a hidebound, timber-headed manner which frequently results in practice in a superior form of fitting being barred because it bears no mark of having passed official inspection, and which, if persisted in, will assuredly destroy practically all initiative to introduce or adopt improvements.

Inchinnan Airship Works.

SOME time ago the large airship station at East Fortune, near Haddington, was sold to Murray, M'Vinnie and Co., a well-known Glasgow firm of ship chandlers, machinery and metal merchants. That station is now being dismantled. The same firm, it is announced, has purchased the Inchinnan Airship Works near Glasgow from the Disposals Board, the sale also including the site of the works and the adjoining aerodrome, extending altogether to about 70 acres. The Inchinnan works were used during the war by William Beardmore and Co., Limited, for the construction of airships and aeroplanes, but were subsequently taken over by the Air Ministry and were transferred to the Disposals Board for sale last October. The works include a large shed about 800ft. long, 120ft. wide, and 230ft. high, in which the celebrated airship R 34, which made the first and so far only trip across the Atlantic and back again, was built. This shed, and most of the erections on the site, will, it is understood, be demolished. Some of the smaller sheds and buildings will, however, be retained, and may be used for factory purposes.

Camellaird-Fullagar Motor Ships.

IN this Journal of June 30th we referred to the three electrically-driven motor ships which are being built by Cammell, Laird and Co., Limited, for the United Fruit Company of America. The first of these vessels, the La Playa, was launched at Birkenhead on Tuesday. She has the following dimensions:—Length between perpendiculars, 325ft.; moulded breadth, 48ft.; depth to upper deck, 31ft. 9in., and will have a speed of 14 knots. The main propelling machinery will comprise four sets of four-cylinder Cammellaird-Fullagar engines, running at a speed of 250 revolutions, and will be coupled direct to 220-volt continuous-current main and auxiliary generators arranged in tandem. This machinery is placed amidships, but the main propelling motor is accommodated right aft in the ship, eliminating the shaft tunnel and giving a clear after-hold for the carriage of fruit. The main generators are electrically coupled in series, so that although all four sets are in operation when running at full power, three, two, or only one set may be used at reduced powers, very economical operation thereby being achieved. A feature of the control arrangements is, that the main propelling circuits are never interrupted, all regulation and reversing being carried out by varying the field circuits only. The ship is equipped with electrically-driven auxiliaries, which include a large refrigerating plant for the fruit spaces, while a small oil-fired boiler is provided for heating purposes and for supplying steam to the fruit elevators on shore. The whole of the electrical machinery is being supplied by the British Thomson-Houston Company, Limited, of Rugby, and has been specially designed to meet tropical climate shipboard conditions.

Successful Voyage of Corrugated Ship.

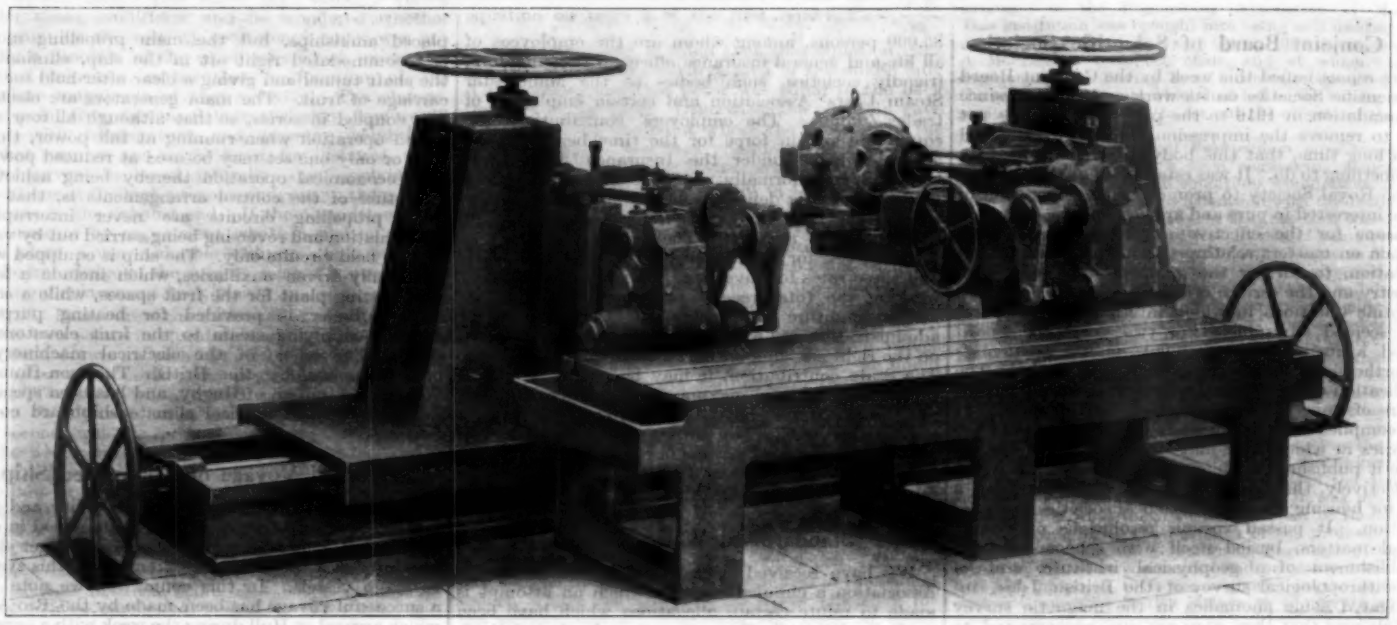
THE influence of form upon the stability and propulsion of a ship has recently been discussed in connection with the fitting of bulges to passenger ships, and interest attaches to the extension of this system to cargo vessels. In this connection we note that a successful voyage has been made by the Rio Azul, which arrived at Hull during the week with a cargo of 7000 tons of rice from Bangkok. This ship is one of the corrugated ships built by the Blyth Shipbuilding and Dry Docks Company, Limited, and is so called on account of the four corrugations giving two bulges on each side of the hull with which she is provided. The system is claimed to give additional cargo space, to lower the fuel consumption and to increase the seaworthiness. On her recent voyage from Bangkok to Hull she consumed 13½ to 14 tons of coal per day at an average speed of eight and one-third knots, and her owners attribute this good result to freedom from rolling, with the consequent diminution of propeller slip which her form gives. The Rio Azul is one of three 4000-ton, 375ft. ships owned by Petersen and Co., of London. She is fitted with triple-expansion steam machinery, with coal fired boilers working under forced draught.

Sixty Years Ago.

APART from a report of a lecture delivered at the Royal Institution by Mr. (later Sir) William Crookes on his discovery of the metal thallium by spectroscopic methods, our issue of April 17th, 1863, was dominated by the attention which it paid to various aspects of gunnery, and iron-plated ships. Interest in naval matters was, at the time, very intense, for the period was one of revolution in accepted ideas. The use of iron-clad batteries in the Crimean War eight years previously had marked the beginning of the new epoch, and the Civil War then in progress in America was daily putting to the test freshly established theories and pointing new lessons. A long paragraph entitled "Ironclads in Action" gave particulars of several engagements fought between the gunboats Chillicothe and De Kalb on the one side and the Confederate works in the Yazoo on the other. The account gave the impression that the ironclads did not come out of the attacks as scatheless as was expected of them. In one affray the Chillicothe suffered damage and loss by the impact of a rebel shell on the muzzle of one of her guns, which was on the point of being discharged, both shells exploding simultaneously. The vessel was brought out of action, but was engaged again two days later. At the meetings of the Institution of Naval Architects guns and armour occupied sole attention, papers on the subject being submitted by Mr. (later Sir) W. Fairbairn, Mr. J. D'A. Samuda and Mr. Scott Russell. An account was given of a visit paid by the Lords of the Admiralty to the new armour plate works then recently erected in Sheffield by Mr. Brown, the mayor of that city—an extension, of course, of the Atlas Works of the firm known to-day as John Brown and Co., Limited. At a dinner subsequent to the inspection the First Lord of the Admiralty, the Duke of Somerset, delivered himself of certain remarks regarding armour plate and inventors which were of such a nature as to cause us severely to castigate him in a leading article. We were principally at variance with him because of the ridicule which he poured upon the idea of an invention under which springs were to be placed between the armour and the vessel, in order to deaden the shock of a striking shell. He held the idea up to scorn on the ground that it would be impossible to preserve the springs from the action of sea water. We, however, argued that they could be so protected, and that the idea was worthy of immediate trial on the ground that just as the stresses in a gun would be greatly increased by preventing its recoil, so, too, the stresses in armour plating would be lessened if it could be made to yield against springs.

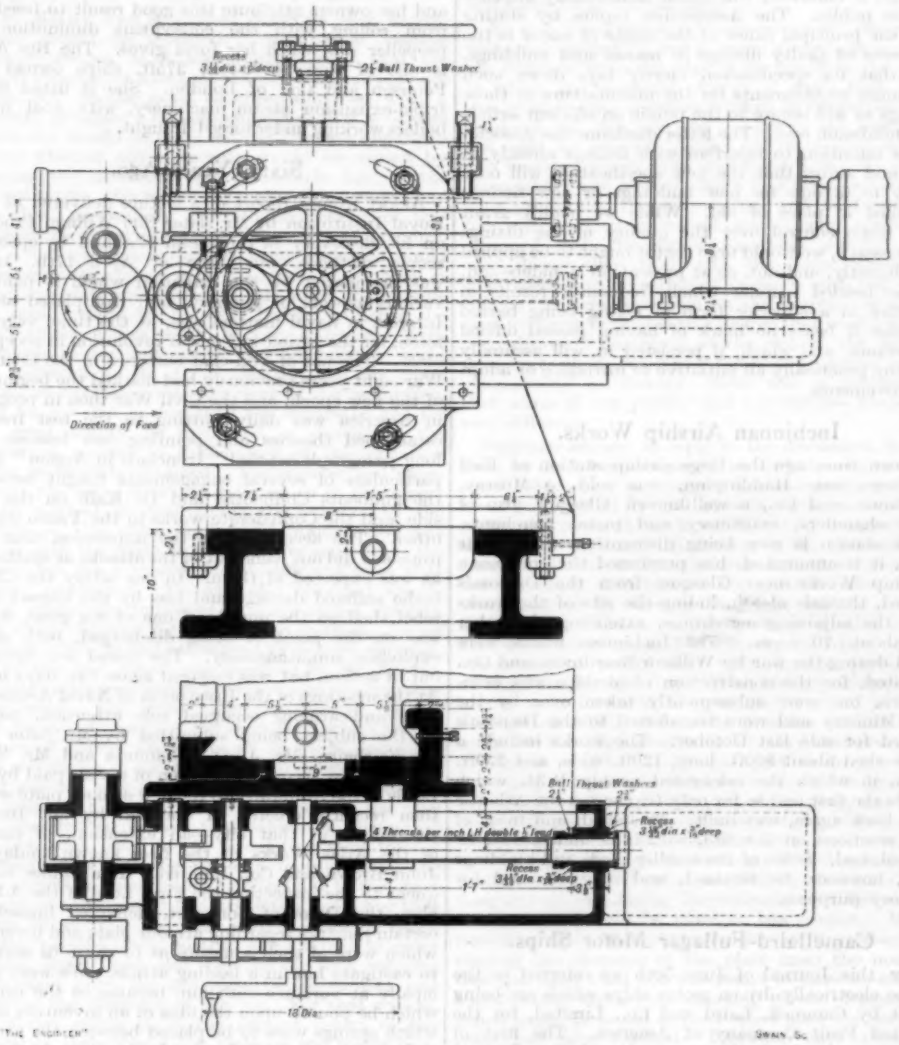
DOUBLE-HEADED PLATE-SCARFING MILLING MACHINE

NOBLE AND LUND, LIMITED, FELLING-ON-TYNE, ENGINEERS



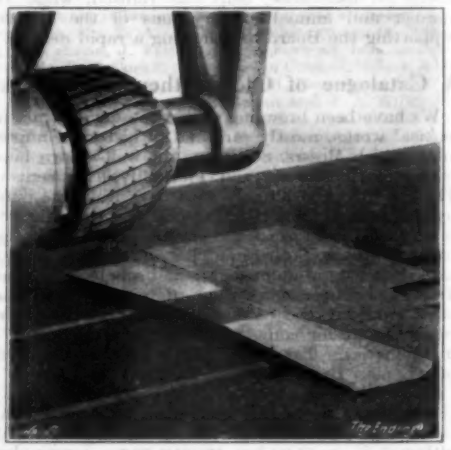
Double-headed Milling Machine for Scarfing Plates.

In order to perform the scarfing of the plates used in the manufacture of steel pipe lines, the double-headed milling machine illustrated herewith has been produced and installed in certain North-East Coast works by Noble and Lund, Limited, of Felling-on-Tyne. Plates up to 7ft. 4in. in width can be accommodated in the machine, and when set in position are fixed to the work table and remain stationary thereafter until the scarfing is completed. Both corners of the work are machined simultaneously, but independently, each milling head being separately driven by an electric motor and separately adjustable lengthwise and crosswise and as to depth and inclination. Each milling head is mounted on a column which can be moved along the bed by means of a hand wheel and screwed shaft. The column is provided with vertical guiding surfaces whereon a saddle slides for adjustment and feeding purposes under the control of a hand wheel at the top of the column. The saddle in turn is equipped with a swivelling plate, which is set to suit the desired angle of the scarf and which provides cross guides for the support of the slide carrying the cutter arbor, the electric motor and other details. From the motor shaft power is transmitted to the cutter arbor first through hard gun-metal worm gearing and then through a pair of pinions connected by an idler. The motor is of 5 brake horse-power, and runs at 800 revolutions per minute.



DETAILS OF ONE OF THE MILLING HEADS

Within the slide a screwed shaft is journaled parallel with the motor shaft and engaging with a nut fixed to the face of the swivelling plate. This shaft provides the means for adjusting the slide on the swivel plate guides and for feeding the slide during the cutting period. The adjusting movement is effected by hand from a wheel on the front face of the slide. For feeding purposes power is communicated to the hand wheel shaft through a dog clutch and a train of gearing driven from the idler wheel of the arbor drive. The feed of the cutter takes place in the direction from the top of the scarf towards the edge of the plate. Automatic knock-off gear is provided to stop the feed after the scarfing has been completed. The cutter



CUTTER AND SAMPLE OF WORK

arbor rotates at 38 revolutions per minute, so that with a 6in. cutter the cutting speed is 60ft. per minute. The feed provided is 1in. per minute.

DEVELOPMENT WORKS IN NORTH ISLAND OF NEW ZEALAND.

There is, according to the *Christchurch Weekly Press*, every indication that the present year is going to see a big move forward in the development of the East Coast of the North Island of New Zealand. The Minister of Public Works has promised that, with the completion of the North Auckland Railway and the Otira Tunnel, work on the East Coast Railway shall be expedited, men and plant being brought from other districts.

The Gisborne Harbour Board expects shortly to initiate its scheme of harbour construction, for which the ratepayers have given sanction to a loan of £750,000. The new engineer, Mr. Robert Campbell, is vigorously preparing for the execution of the work. A local engineer has also been appointed temporarily to investigate and survey localities likely to yield supplies of stone, of which extensive quantities will be required.

The Cook County Council has adopted a scheme for the expenditure of £190,000 on concreting and tar-grouting the main roads of the county, and other counties in the district are engaged upon works of a similar nature. The Public Works Department is busy with the metalling of the road connecting Gisborne with Napier.

There is also a proposal immediately to set up a power board to develop a hydro-electric scheme for the district. A conference of local bodies will be held at an early date, and is expected to take the necessary preliminary measures for the formation of a board. It is probable that the works commenced at Waikohu, where a large dam was

being constructed, will be taken over, though the possibilities of linking up with Waikaremoana will also be considered as an alternative.

The Gisborne Borough Council has in hand a £60,000 contract for tramway extension, and the erection of a ferro-concrete bridge across the Taruheru River, and has arranged for a further £35,000 to build another concrete bridge across the Turanganui River, connecting the suburb of Kaiti with the town.

The Kia Ora Dairying Company has decided upon the erection of a new factory to cost between £7000 and £8000. Architects and builders report signs of renewed activity in the building trade, following upon the improvement in the pastoral industry, which has given heart to farmers and business people.

Performance of Steam Wagons.

In the course of a paper on the "Use and Limitations of the Steam Wagon," presented before the Institution of Automobile Engineers, Mr. C. Le M. Gosselin said that the number of useful days of work per annum may roughly be put at 250. This allows for 52 Sundays, 52 shed days for washing out boilers and cleaning down, and allows only 11 days for special repairs and holidays.

Length of Economic Journeys.—It is difficult to define a limit to the length of the journey, but roughly it may be stated that a minimum of 5 miles and a maximum of 35 to 40 miles represents the economic limit, beyond which other types of vehicle would probably give more economic service.

Fuel Consumption.—The consumption of fuel varies enormously, according to the nature of the roads and the weight carried, but on present-day main roads with from 9 to 10 tons useful load, it is not uncommon to get 10 miles per cwt. of gas coke, and nearly double that mileage with good Welsh steam coal. Much, however, depends upon the driver, and in the author's own fleet, where the coke consumption per vehicle is taken out monthly, it varies from $6\frac{1}{2}$ miles per cwt. for the worst wagon up to 10 miles per cwt. for the best.

Repairs.—The question of repairs is one of prime consideration. A stitch in time indeed saves nine in running steam wagons, which require on the whole constant attention. Boiler fittings and pipe joints are particularly troublesome, the former owing to the dirt carried through with the water and the latter owing to vibration. It should not be beyond the wit of man to invent some form of filter suitable for attachment to the end of a suction hose pipe, and yet up to now only the crudest form of obstruction to mud and small stones is fitted to steam wagons.

Boiler Repairs.—The boilers are still troublesome—unnecessarily so. An engine will last from two to three years without serious overhaul, and boiler repairs should synchronise with engine overhaul if the best service is to be got out of a vehicle. Many boilers hardly give twelve months' continuous service. Beyond the above-mentioned repairs, there is nothing about a steam wagon which calls for special attention. Springs break when exceptionally bad roads are encountered or when they are grossly overloaded, and wheels run hot when lubrication is denied to them, but, after all, that concerns the abuse rather than the use of the vehicle.

Frequency of Renewal of Main Working Parts.—The following is a rough *résumé* of the chief periodical renewals on a fleet of Leyland steam wagons:—Boilers re-tubing, 18,000 to 20,000 miles; engines overhauling, 25,000 to 30,000 miles; chains and chain sprockets renewing, 20,000 to 30,000 miles; rubber tires, rear and front wheels, 16,000 to 20,000 miles; trailer tires, 20,000 to 30,000 miles; gears, many must have been in use eight to ten years and still appear excellent; total useful life of a boiler, estimated at six to ten years, according to nature of water and work.

Depreciation.—From the above we naturally turn to the question of depreciation. It is no exaggeration to say that if a wagon is consistently maintained in good working order its useful life is something well over ten years, and examples are known of vehicles of twice that age still doing good service. In view, however, of the possibility of improvements in design or of superior types of vehicles becoming evolved, it is wise to limit the economic life of a vehicle to ten years at the outside, and preferably to seven years.

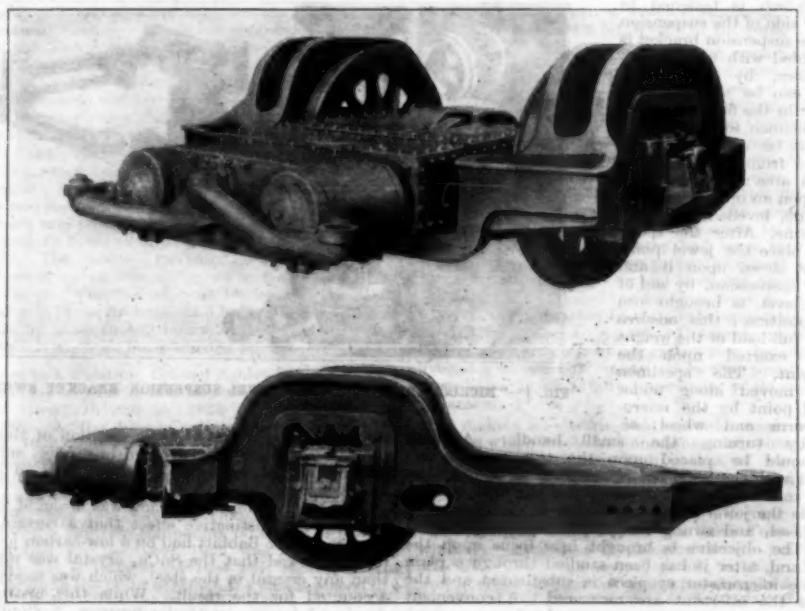


FIG. 2—AMERICAN TRAILER TRUCK FITTED WITH BOOSTER

Boosters for Locomotives.

In THE ENGINEER of January 4th, 1901, was illustrated a 4–4–2 express engine shown at the Paris Exhibition of 1900, by the Krauss Locomotive Works, Munich, in which an auxiliary engine was employed to drive a small extra pair of wheels, placed between the wheels of the leading bogie. The use of this auxiliary engine was explained by Mr. R. v. Helmboltz, the engineer of the Krauss Company, in a letter which appeared in this journal of July 6th, 1900. From that communication the following passage is quoted:—"The intention is to have a locomotive which, in general, has the qualities of a four-coupled engine, but is able to increase every time it is needed its cylinder power as well as its adhesive weight in the proportion of 3 : 2, so that it can temporarily exert a tractive power corresponding to six coupled wheels. In such cases, namely, when starting and accelerating heavy trains, or in ascending steep gradients, the auxiliary axle can be pressed down, its cylinders switched in, and the small engine used as a pilot for the main engine. As the assistance of the auxiliary engine can only be wanted at a limited speed, the diameter of its driving wheels can be made considerably smaller than that of the main drivers."

This locomotive was not the first to be built by Messrs. Krauss with an auxiliary engine, for in 1895 they had constructed a 4–2–2 engine with single driving wheels for the Bavarinn railways, in which a similar system was adopted.

There does not appear to have been any extension of the principle, for shortly afterwards the Bavarian railways adopted the 4–6–0 type of locomotive, which at that time did away with the necessity for the auxiliary engine. Moreover, the arrangement was non-automatic, in that it remained for the driver to switch the auxiliary out of action, and if he did not do so soon enough, the high speed of revolution of the auxiliary driving wheels, which were only 3ft. 3¾in. diameter, was liable to become excessive.

Within the last three years American locomotive engineers have adopted an arrangement, the principle of which is somewhat similar, but the method in which it is carried out is different. In order to obtain a large fire-box widened out over the frames, the 4–6–2, 2–8–2 and 4–8–2 types of locomotives have been multiplied in the States. The idle trailing carrying axle has one disadvantage in American eyes, in that the weight upon it is not available for adhesion, and it was, therefore, decided to use this existing axle instead of providing an additional one for the auxiliary engine. Moreover, in order to limit the maximum speed at which the auxiliary engine is to work, the arrangement is semi-automatic. When starting, or at any speed below the maximum allowed, the driver can switch the auxiliary into action, but when this maximum is exceeded, the "booster," as it is termed, automatically ceases to operate. For freight engines this limiting speed is in the neighbourhood of 18 to 20 miles per hour, and for express engines about 24 miles per hour.

The question may be asked as to how the boiler is to provide steam for the auxiliary engine. The answer is that in the modern engine with large boiler, there is usually a surplus of boiler power when starting and at low speeds, and it is only at this time that the booster is in operation. As the speed of a heavy train increases, and the demand for steam overtakes the amount which the boiler can economically supply, the "booster" is automatically cut out of action.

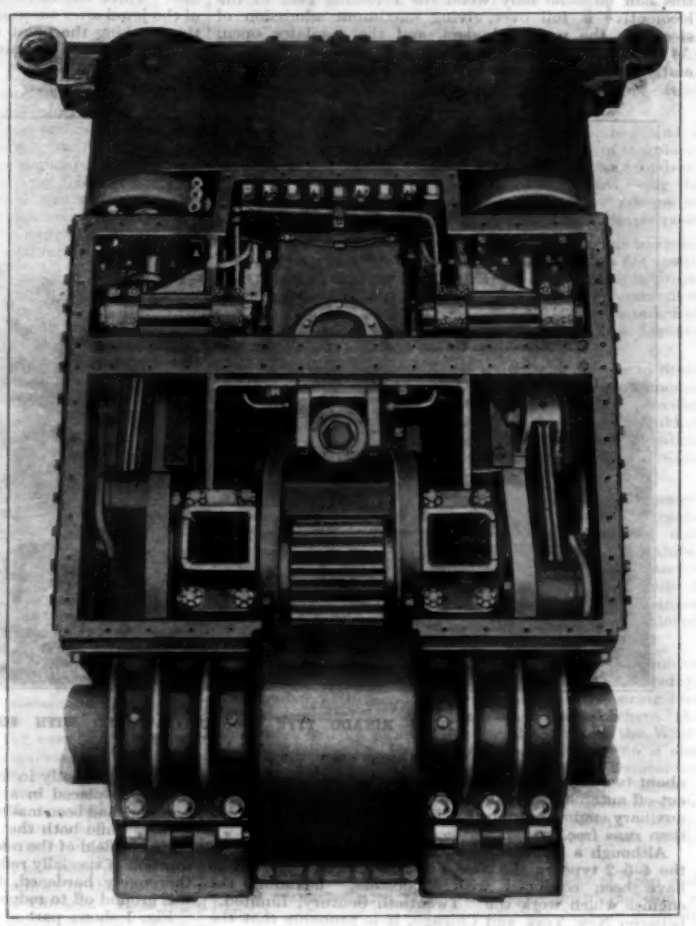


FIG. 1—VIEW OF TYPE C1 BOOSTER WITH COVER REMOVED

The diagram—Fig. 3—which has been taken from a paper read by Mr. George M. Basford before the New York Railroad Club in May, 1921, shows the results of the application of a "booster" to an American 4–4–2 express engine, with 20½in. by 26in. cylinders and four coupled wheels 6ft. 5in. diameter. Fifteen years ago this type of engine was the standard for express trains on many roads,

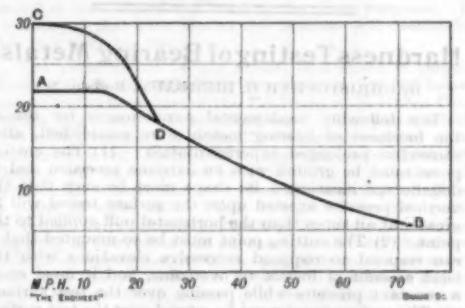


FIG. 3—DRAW-BAR PULLS WITH AND WITHOUT BOOSTER

but was superseded by the 4–6–2 type, owing to the low starting and accelerating power with heavily increased train loads, though it has sufficient power to keep the trains moving at scheduled speeds when once well away.

The line A B shows the draw-bar pull on level track for speeds up to 72 miles per hour. The vertical ordinates are measured to a scale of 1000 units. C D shows the additional draw-bar pull when the "booster" is in operation. When the engine starts the draw-bar pull is augmented from 22,000 lb. to 30,000 lb., an increase of about 36 per cent. At 12 miles per hour the draw-bar pull is 29.4 per cent., and at 20 miles per hour 12 per cent. greater.

At the point D, when the speed attains about 23 miles per hour, the "booster" is automatically cut out, and the draw-bar pull is that normally exerted by the engine at that speed, about 18,500 lb.

Fig. 2 shows two views of an American trailing truck

as used on the Michigan Central Railroad with "booster" attached. The cylinders, which are 10in. by 12in., are placed under the footplate at the back of the truck. A view of the "booster" engine from above, with cover removed, is shown in Fig. 1. The engine is non-reversible, with one excentric to each cylinder, the cut-off being fixed. The connecting-rods drive a shaft placed in front of the truck axle, and between the bearings of this shaft is placed a pinion, which drives a spur wheel on the truck axle through the intermediary of an "idle" pinion. The idle pinion can be brought into gear by the driver by means of a control valve operated by compressed air, but this can be done only when the reversing gear of the locomotive is full over, giving maximum admission of steam to the main cylinders, and the regulator open. As speed increases the main reversing gear is notched up, and when this movement has reached the equivalent of about two notches, the steam supply to the "booster" is cut-off automatically, the idle pinion disengaged, and the auxiliary engine is stopped. The axle of the trailing truck then runs free.

FIG. 4—MIKADO TYPE LOCOMOTIVE FITTED WITH BOOSTER

Although a considerable number of express engines of the 4–6–2 type on the New York Central and other lines have been equipped with "boosters," including the engines which work the "Twentieth Century, Limited," between New York and Chicago, it is probable that the auxiliary engine shows to best advantage in freight service, not only in starting very heavy trains but in hauling them up steep gradients. For this purpose the 2–8–2—"Mikado"—type of locomotive, provided with a "booster," is coming into favour. Fig. 4 shows an engine of this class at the head of a heavy coal train. One hundred and ninety such engines have recently been ordered for the Michigan Central Railroad.

Mr. Basford, in the paper previously mentioned, quotes the following results of tests with a 4–6–2 freight engine on an important railway:—(1) An increase of 23 per cent. in train tonnage; or (2) an increase of 12 per cent. in speed over the division in question; (3) an increase of 18 per cent. in draw-bar pull at 7½ miles per hour; (4) an increase of 13 per cent. in draw-bar pull at 13 miles per hour; (5) an increase of 22 per cent. in starting power.

The writer is indebted to the courtesy of Mr. Basford for the illustrations.

Hardness Testing of Bearing Metals.*

By CHRISTOPHER H. BIERBAUM, Buffalo, N.Y.

THE following fundamental requirements for testing the hardness of bearing metals were established, after somewhat prolonged experimentation:—(1) The cutting point must be ground with an extreme precision and to definite specifications; its shape must be such that the vertical pressure exerted upon the surface tested will be greater at all times than the horizontal pull applied to the point. (2) The cutting point must be so mounted that it can respond to required successive elevations with the least amount of inertia to overcome, and it must exert a constant pressure while passing over the test surface. (3) The cutting point must be moved over the test surface at a uniform rate, slowly enough so that no additional indentation may occur by stopping on the softest crystal.

Various materials were experimented with when seeking a suitable cutting point: one that would be hard enough for all ordinary metals and their alloys, if possible including hardened tool steel: one having the necessary hardness and the microscopic homogeneity to permit it to be ground to an extremely accurate point. On account of its hardness the diamond was the first material suggested, but its grinding has proved unsuccessful. Various other jewels have been tried, the sapphire, tourmaline, ruby, garnet, also various grades of special steels and tungsten. The artificial leuco sapphire (fused Al_2O_3) has proved extremely satisfactory, in that it has the necessary homogeneity, and is much harder than the crystals in the ordinary metals, including martensite in hardened steel and tin oxide (fused SnO_2). The latter is the hardest crystal so far encountered in any of the alloys or their impurities; its hardness is more than twice that of martensite.

After the selection of a suitable jewel, considerable difficulty was experienced in grinding a point that would be sharp and accurate to the extreme limits of the microscope. The grinding of a conical point was early abandoned as being impossible; the point that was finally ground successfully was the corner of a cube or a solid right angle. The jewel was cylindrical in form, 0.022in. in diameter and 0.08in. in length. It was cemented securely into a close-fitting hole in the end of the grinding stylus that made an angle of 54.73 deg. with the grinding disc. Three successive facets were ground upon the end of the jewel after successively rotating it through 120 deg., thus making the point the corner of a cube. The jewel point is mounted so that the diagonal of the cube shall be normal to the surface to be tested and with one edge advancing directly in line of motion. After grinding, the jewel was placed in a jig and, after all adjustments for accuracy had been made, cemented into the end of a flexible spring, while both the jewel and spring were held in the jig in the field of the microscope; the cement was a heavy solution of specially refined shellac. After the cement was thoroughly hardened, the excessive length of the jewel was ground off to reduce it to a minimum weight.

Fig. 1 shows part of a microscope complete and ready for work, equipped with the instrument developed for research on bearing metals; the name chosen for the instrument is Microcharacter. The instrument may be described as a mechanical stage with two additions, the jewel bracket at the right and the micrometer feed at the left. The jewel bracket is provided with a vertical rack for raising and lowering the bracket that carries the jewel suspension. This jewel suspension consists of a balanced arm, pivoted on sapphire bearings, one end of which is provided with a spirit level and the other with a weight, which constitutes the load for the jewel point. The jewel is mounted in the small end of a tapered steel spring, the other end of which is fastened to the lower side of the suspension arm. The suspension bracket is also provided with two adjusting devices, by which the microcut can be shifted so as to appear in the field of vision.

The specimen to be studied should not be more than ¼in. thick, and from 1 to 2 square inches in area; it should be placed upon an ordinary microscopic slide, levelled, and held in Plasticine. After the specimen is in place the jewel point is brought down upon it and the jewel suspension, by aid of the spirit level, is brought into a level position; this ensures that the full load of the weight is being exerted upon the jewel point. The specimen is then moved along under the jewel point by the micrometer worm and wheel actuated by turning the small handle. A drop of oil should be placed upon the test surface and in contact with the jewel before starting, for a somewhat smoother microcut is then made. After the microcut has been made the jewel bracket is elevated, by turning the knurled head, and swung out of position, as shown in Fig. 1. The objective is brought into focus upon the microcut and, after it has been studied through a plain ocular, the micrometer eyepiece is substituted and the widths of the microcut are measured. A convenient weight upon the jewel point seems to be 3 gm., as with this load readings can be made upon the softest lead as well as upon the hardest steel without any change in the microscope set-up.

The micron, 0.001 mm., seems to be a convenient unit for our purpose. As the various cross sections of microcuts in the different metals and alloys are symmetrical and their areas are proportional to the squares of their respective widths, these squares should be used for comparison. The same should appear as a factor in the mathematical expression for the value which may be designated as micro-hardness. For the reason that the greater widths represent the softer material the reciprocal of these squares should be used. Let κ represent the micro-hardness and λ the width of microcuts; then, after multiplying by a convenient constant to avoid unwieldy numbers, $\kappa = \lambda^{-2}\,10^4$. In Fig. 2 this formula has been plotted to two rectangular co-ordinates covering an ample range of microhardness.

The microhardness of grains in most metals varies in different directions; that is, if a grain on a polished metallographic specimen is cut in different directions the results vary within certain limits, and these limits vary for different metals. The relative hardness of the different grains in an alloy is readily measured with this instrument. It has long been known that "burned" bronze was destructive to bearings. The actual hardness of the crystal, however, does not seem to have been determined before this as being more than twice that of hardened tool steel; it is by far the hardest crystal found in any of the common alloys or their impurities.

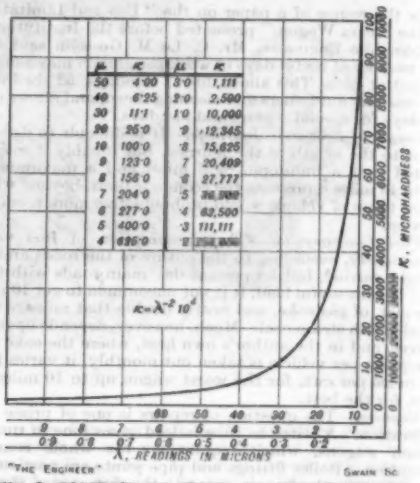


FIG. 2—DIAGRAM OF SCALE OF MICROHARDNESS

Name of substance.	Width of microcut, average.	Micro-hardness, average.
Lead, c.p., Picher	37.7	7.03
Tin, c.p., electrolytic	29.3	11.7
Copper, c.p., Raritan	11.8	78.4
Antimony, commercial	9.1	121.0
SnSb crystal as found in Babbitt	6.9	208.0
Nickel, c.p., International Nickel Co.	6.4	244.0
PCu_3 crystal as found in phosphor-bronze	6.1	267.0
Iron, Swedish, softest crystal	4.8	420.0
Cobalt, c.p., International Nickel Co.	4.0	625.0
$SnCu_3$, or delta crystal in copper-tin bronze	3.6	750.0
$SnCu_4$, hardest crystal in high-Cu hardened Babbitt	3.2	1006.0
Hardened steel—Johansson test blocks	2.2	2229.0
SnO_2 (fused) as found in burned bronze	1.4	5390.0

By the use of this instrument it has been clearly shown that the addition of zinc, in excess of 2 per cent. to a copper-tin bearing bronze, increases the hardness of those crystals which, without the zinc, would have been the softest. This addition of zinc, therefore, tends to reduce the range of hardness between the hardest and softest crystals and theoretically reduces the bearing value of such an alloy. This offers a most striking corroboration between theory and practice, for it has long been known that the hardening of bearing bronzes by the addition of zinc increases the rate at which they wear off in service, and that this destructive wearing effect increases with an increase of zinc content.

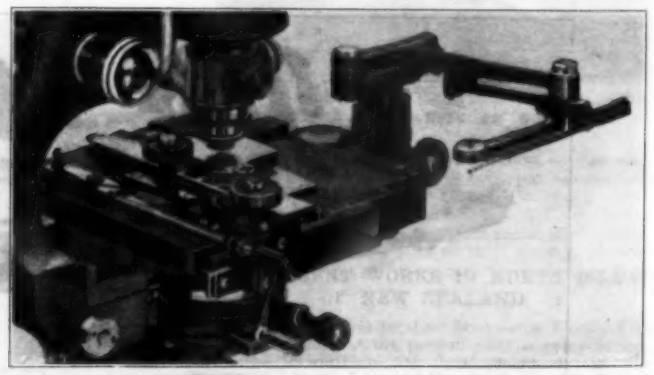


FIG. 1—"MICROCHARACTER" WITH JEWEL SUSPENSION BRACKET SWUNG OUT

An equally interesting fact was brought out in the study of the distinctive effect that a certain high percentage copper Babbitt had on a low-carbon journal; the results showed that the $SnCu_4$ crystal was much harder than any crystal in the steel, which was unexpected and accounted for the result. While this instrument was developed for one particular purpose, it should prove of greater interest as it offers means for investigation and research that have not been available heretofore.

* From a paper read before the American Institute of Mining and Metallurgical Engineers, Inc., February, 1922.

THERE was another buffer-stop collision at Liverpool-street terminus on the morning of Friday, the 13th inst. A train from Chingford was involved, and 53 passengers complained of injury or shock.

Railway Matters.

FIVE halts are to be provided on the Central Wales and Cambrian coast sections of the Great Western Railway. They will afford facilities for visiting beauty spots hitherto not easily accessible.

GOOD progress was made on Tuesday last in the conversations between the railway companies' representative, and the unions as to modifications in the terms of service. The companies are now to submit their proposals.

THE London correspondent of the *Manchester Guardian*, writing under date April 13th, says he understands that the meeting of railway managers last Tuesday week, which officially was "adjourned till a date to be fixed," decided to make a reduction of 25 per cent. on existing rates. The lower scale, he is told, will come into operation on June 1st—if not possibly earlier. We believe our contemporary is to a certain extent correct, but has got confused between a reduction of 25 per cent. and a reduction from 75 per cent. above pre-war level to 50 per cent. above.

THE recent accident to the combined road and river bridge over the Swale—the only communication other than by boat between the mainland and the Island of Sheppey—would not have happened nor the island become isolated had not the local authorities opposed in 1902 a Bill deposited by the South-Eastern and Chatham Joint Managing Committee for a new bridge over the river at that point. The Bill passed the House of Lords, but in committee in the Commons such restrictions, at the instigation of the local authorities, were put in the Bill that it was withdrawn.

A CONTRACT for completing the Guatemalan link of the Pan-American Railroad system has been entered into between the Government of Guatemala and Mr. Minor C. Keith, of New York. The new line is to run from the city of Zacapa to the border of El Salvador, an extension of 65 miles passing through Chiqimula. Work will start as soon as the Guatemalan Congress ratifies the contract, which grants to Mr. Keith a concession for the line for eighty-six years and a subvention amounting to about 1,500,000 dollars. With the construction of the new line there will be continuous rail connection from New York to the Salvador border.

NEWTON ABBOT is a very important station on the Great Western. At the west end is the junction for the Torquay-Kingswear branch and at the east end the junction for the Moreton Hampstead branch. It is also one of the principal locomotive centres, as engines are changed there, except those on the non-stop expresses, in view of the gradients of 1 in 40, 1 in 42, and 1 in 47 for 13 miles, between Newton Abbot and Rattery. The present station buildings formed part of the original structure built by J. K. Brunel for the South Devon Railway. The whole is now to be modernised so as to be in keeping with the importance of the place as a railway centre and a business town.

UNTIL quite recent years railway companies treated with a contempt which was more apparent than real any complaints in the Press. A different attitude is now taken. On several occasions there have been replies by Mr. Tempest, of the South-Eastern and Chatham, and the other day Sir Herbert Walker, evidently writing as chairman of the general managers' conference, published in the *Times* an answer to a letter on railway rates from Mr. George Lambert. Now he has replied in the same paper to a complaint on April 9th from Lord Farrer, as to the continental services. One grievance dealt with was that there are to-day two services less than before the war. Mr. Tempest admits this, but says that the services now are spread out so as to cause no inconvenience. The present turbine steamers, with their carrying capacity of over a thousand passengers each, amply meet the requirements. As soon as the traffic warrants the expense extra services will be put into operation.

THE new "Pullman Limited," on the London and North-Eastern Railway, to which reference was made herein on the 13th inst., will leave King's Cross at 11.15 a.m., arrive at Leeds at 2.40 p.m., and at Harrogate at 3.15 p.m. The 185½ miles between London and Leeds will thus be covered regularly in 3 hours 25 min. without a stop. In the reverse direction the Pullman express will leave Harrogate at 11.15 a.m., Leeds at 11.50 a.m., and will reach King's Cross at 3.15 p.m., the 208 miles on the throughout journey being covered in 4 hours. It is understood that the train, in addition to the brake-van, will consist of two first-class and four third-class Pullman cars, each of these cars being 63ft. 10in. in length over buffers, and weighing 44 tons. The total weight of the train will be 290 tons. The train will run into the Central Station at Leeds, where it will reverse and go on to Harrogate by the Holbeck Curve. The fastest time between London and Leeds to-day is by an up train in 3 hours 55 min. Before the war an up train took 3 hours 25 min., and called at Holbeck and Wakefield, but it carried no restaurant cars.

IN answer to a question, Colonel Ashley has stated that the expenditure on salaries and wages by the railway companies in Great Britain in 1922 was approximately £117,000,000. At the rates of salaries and wages in force in August, 1920, they estimate that the expenditure was at the annual rate of approximately £154,000,000, and at the March, 1923, rates, of £111,000,000. The expenditure on salaries and wages for the year 1913 was approximately £47,000,000. The total amount charged to locomotive running by the railway companies of Great Britain in respect of fuel for the year 1922 was approximately £15,000,000. It is understood that this represents the expenditure up to the point at which the coal is placed in a locomotive tender. The approximate annual expenditure on fuel for the year 1920 on the same basis was £25,000,000. For the year 1923, if the February level of prices and consumption be assumed, the expenditure on fuel is estimated at approximately £14,000,000. The expenditure for 1913 was approximately £8,500,000. The depreciation and reserve funds shown in the balance sheets of the railway companies in Great Britain at December 31st, 1922, amounted approximately to £130,000,000. The corresponding figure at December 31st, 1913, was approximately £20,700,000.

Notes and Memoranda.

IN a letter to the *Electrician* Mr. W. M. Selvey expresses the opinion that a "boiler efficiency" of 85 per cent. is possible with steady working, and that the whole of the units used for auxiliary plant, both in engine and boiler-houses, need not exceed 15 per cent.

ACCORDING to Dr. Steinmetz the voltage of the lightning flash of a real thunderstorm is 50,000,000 volts. The artificial lightning represents, while it lasts, more than a million horse-power. The estimated horse-power of a natural lightning flash is estimated at 500,000,000 horse-power.

THE Peak of Itabira do Campo, in Brazil, is perhaps the most striking mineral outcrop known. It is composed of the purest iron ore, and as it rises 300ft. from a plateau, the large quantity of ore at this place is evident. A number of outcrops of similar, if less striking, appearance, exist in the surrounding country. On account of the distance of the deposits from the seaboard, the transport problem is, however, a serious one. In recent years European and American purchasers have acquired most of the principal deposits, and various schemes have been proposed to export the ore. The expenditure of a large sum in the construction of a mineral railway and shipping port equipment is a first essential.

TWO new specifications have recently been issued by the British Engineering Standards Association. One deals with air-break knife switches and laminated bush switches for voltages not exceeding 600 volts, and the other with air break circuit breakers, not exceeding 600 volts. These specifications were first issued in 1921, but it has been found necessary to revise the sections covering the tests. A number of terms used in modern switchgear practice have been defined and a series of standard sizes has been included. Dimensions of back connections and the distance apart of the stud centres of knife switches have been agreed upon, so as to secure a reasonable amount of interchangeability without interfering with details of design.

A NEW type of electric condenser, described in the columns of a contemporary, is composed of plates or ribbons of a special quality of celluloid—"cellon"—upon both sides of which are chemically deposited thin films of silver. The "cellon" employed can stand a potential gradient of 40,000 volts per millimetre, and has a specific inductive capacity of 4.0. Dielectric losses are of the order of 1 per cent. at periodicities of 50-cycles. Edge-losses are reduced by surrounding the edges of the silver deposit by a very thin, highly resistant border of silver. The losses can thus be reduced to from 0.1 to 0.2 per cent. of the apparent power in the case of a battery of condensers for power factor improvement. The condensers are mounted in a porcelain cylinder with metallic caps, so that they may be connected in series by superposition. Advantages are claimed, amongst others, for extreme silence in radiotelephony, due to the close adherence of the chemically deposited silver to the plates.

A FORM of earthing plate which has been proved to be very satisfactory is described as follows in the *Bulletin* of the Hydro-Electric Commission of Ontario. It is rolled from a sheet of No. 20 or No. 22 galvanised pure wrought iron as an 8in. diameter cylinder 30in. long. A No. 6 insulated copper wire is rolled into contact with an edge of the cylinder and solder run into the joint, which is then painted with asphaltum to prevent chemical action. This ground cylinder has a useful contact area of at least 5 square feet without including the full inner surface. It is set by boring an 8in. diameter hole to a depth of 7ft. or 8ft. with the same tool as used in setting anchors and dropped to the bottom with the ground wire attached. The cylinder is then expanded into contact with the wall of the hole by ramming the centre full of earth. This ground is at least as easily placed as the driven pipe, costs approximately one-half as much and, considering the depth at which it is placed, has five times the effective area of a 6ft. length of 1in. pipe.

THE wearing of oxygen breathing apparatus following mining disasters, and in the fighting of mine fires, is shown by the United States Bureau of Mines to be hazardous, as is also the case with all work underground at such a time. Bureau of Mines records show that twenty-three men have lost their lives while wearing apparatus at time of disaster, this number constituting about 1.2 per cent. of the persons recorded as wearing apparatus. Four others were fatally overcome wearing apparatus, doing what is termed "rescue manœuvers." From the careful investigation made in each of these twenty-seven fatalities, it was proved that if the apparatus had been kept in proper order, or the men had been properly trained, or had they been physically sound, or had they not attempted to do too much or proceeded too far from fresh air, there would have been no occasion to blame the apparatus, and there should have been no deaths. However, while there is a record of twenty-seven apparatus men having lost their lives, it is known that many times that number of rescue men have been fatally overcome while not wearing apparatus.

IN making an electric weld in commercial cast iron, the surfaces which are to be joined must, of course, be melted. When these surfaces, which consist of iron containing carbon in both the free and the combined states, are melted, several things happen. First, all the carbon goes into solution in the molten metal. Second, some of the carbon, silicon and manganese is burned out by the heat, while the sulphur and phosphorus are practically unaffected. The tendency, therefore, is to produce a cast iron in the weld that will be white when cold owing to its low content of silicon and carbon. Third, the surface of the molten metal oxidises, making a slag, which partly prevents further oxidation. As soon as the welding heat is removed, the melted iron hardens very quickly, giving up its heat to the neighbouring cold metal and to the air. The sudden cooling produces a chilled hard white metal in the weld, the hardness being due to the fact that much of the carbon remains in solution if the cooling is sudden. Of course, if the casting has been preheated before welding, the cooling of the added metal will not be so sudden, and a softer machinable weld may be secured.

Miscellanea.

WE learn with much interest that in the course of his lecture at the Royal Institution on April 27th on "The Measurement of the Heating Value of Gas," Mr. C. V. Boys will deal with his recent work in the recording gas calorimeter.

QUANTITIES of petrol, amounting to between 40 and 85 barrels daily, and natural gas, amounting to between 1,500,000 and 3,000,000 cubic feet daily, can be obtained, according to *Canada*, from the Illinois-Alberta well, west of Okotoks.

THE announcement is made in Birmingham that an association of large users of brass and copper—sheet and strip—has been formed to secure mutual co-operation and to promote the welfare and interests of members in relation to supplies of sheet and strip brass and copper.

ABOUT £2,000,000 is being raised in London, and a similar amount in Australia, for development of the placer gold fields of British Columbia by dredging and hydraulicking, Cariboo, Lillooet, Atlin, and Tulameen being the fields particularly under investigation. New companies are also being organised in California for a similar purpose.

IN accordance with the international agreement whereby Greece has to establish several radio stations for transmitting meteorological bulletins and other useful information to vessels at sea, the first station has been erected on the Attic coast. Of the other stations to be installed at an early date one will be on Samos and another on Lemnos Islands.

IT is announced from Simla that the Secretary of State for India has sanctioned the Sukkur barrage scheme. This scheme, which, our readers will remember, provides for the construction of a barrage or weir below the Sukkur Gorge on the Indus and a number of canals for irrigation purposes, will be one of the biggest undertakings of its kind in the world.

WE have just received from the British Engineers' Association, a ground plan showing the progress of space letting in the Shipbuilding, Marine, Mechanical and General Engineering Section of the British Empire Exhibition, covering an area of 217,000 square feet in the machinery Hall. The first allotment of space was made a fortnight ago, and the plan shows in a striking manner that very remarkable progress has already been achieved in the sale of stand space.

THE Secretary of the Whitworth Society announces that the preliminary dinner is to take place on Tuesday, September 11th next, at the Shipping, Engineering and Machinery Exhibition, Olympia, London, where the members will be received by the chairman of the Whitworth Society, Dr. F. S. Hele-Shaw, F.R.S., who is also chairman of the Committee of Experts of the Exhibition. Anyone eligible for membership, who has not already particulars about the Society, is requested to communicate at once with the Hon. Secretary, Whitworth Society, Institution of Mechanical Engineers, Storey's-gate, Westminster, S.W. 1.

IT is stated by the National Federation of Iron and Steel Manufacturers, that the production of pig iron in March amounted to 633,600 tons, the highest monthly production attained since January, 1921—when it was 642,100 tons. The furnaces in blast at the end of the month numbered 202, an increase of 13 during the month. The production includes 206,300 tons of hematite, 204,600 tons of basic, 144,700 tons of foundry, and 45,900 tons of forge pig iron. The output of steel ingots and castings in March amounted to 802,500 tons, which is the highest since September, 1920, when the production amounted to 884,700 tons.

CONSIDERABLE development work has been done at the salt deposits at Malagash, Nova Scotia, according to the *Chemical Trades Review*. This deposit came into prominence about two years ago as being a very valuable source of natural rock salt, and also as having considerable potash possibilities. Last November a 6ft. seam of pure white salt was unearthed at the deposit, which on analysis showed to be 99.1 per cent. pure sodium chloride. Two zones in the salt strata have been found to contain varying percentages of potash and salt, and from these zones the salt has been mined and used for fertiliser purposes. It is believed that this part of the business will eventually prove a valuable one.

THE construction of the second of a chain of power-houses which will ultimately develop over 600,000 horse-power from the waters of the Pit River in Northern California, is about to be embarked upon. The plant, which will have a capacity of three 27,000 kilovolt-ampère units and involve the expenditure of approximately 17,000,000 dollars, will be completed by 1925. The installation will involve the construction of a diversion dam 125ft. high at a point 2½ miles below Pecks Bridge. From this point a tunnel approximately 22,000ft. in length, having a capacity of 3000 cubic feet per second, will carry the water to a point above the site of the power-house. In connection with the announcement relative to this latest step in hydro-electric development, it is stated that the service is growing at a rate of twenty to twenty-five thousand kilowatts a year of peak load.

THE Paris *Auto* recently published figures showing the increase in motor car construction throughout the world since 1914. A total of 1,836,790 motor cars existed in 1914, increasing to 10,922,278 in 1920, 12,589,588 in 1921, and 14,728,645 in 1922. The United States account for the major part of these figures. In 1914 the United States possessed 1,300,000 motor cars; 9,211,295 in 1920; 10,505,660 in 1921; and 12,364,377 in 1922. Great Britain comes next with 245,000 in 1914 and 554,443 in 1922. Canada holds the third place with 46,000 in 1914 and 487,099 in 1922; France comes fourth with 100,000 in 1914 and 290,303 in 1922; Germany is fifth with 126,092 in 1922. Then in order come Australia, Argentina, Italy, Spain, British India, Belgium, South Africa and New Zealand. The smallest number recorded is two for the Seychelles. The number of motor cars possessed by the United States forms 84 per cent. of the world total. The State of New York alone possesses one million motor cars, or one car to every eight inhabitants.

THE LAKESIDE ELECTRIC POWER HOUSE AT MILWAUKEE

(*For description see page 409*)

FIG. 15—VIEW BETWEEN FRONTS OF BOILERS, SHOWING FIRING GALLERIES

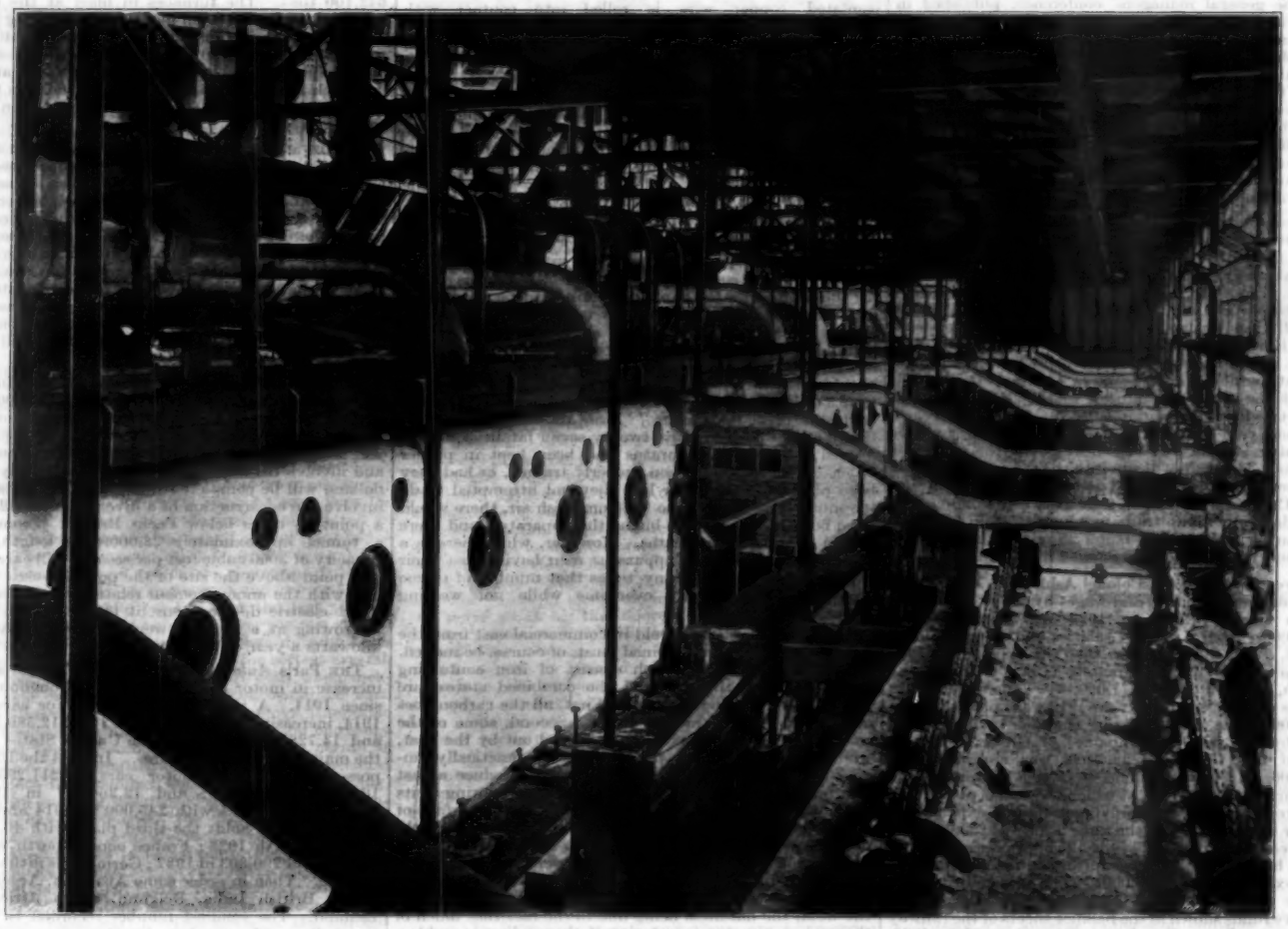


FIG. 16—VIEW AT REAR OF BOILERS SHOWING ECONOMISERS

AGENTS ABROAD FOR THE SALE OF

The Engineer

BUENOS AIRES.—Mitchell's Book Store, 576, Cangallo.
CHINA.—Kelly and Walsh, Limited, Shanghai and Hong Kong.
EGYPT.—Cairo Express Agency, near Shepheard's Hotel, Cairo.
FRANCE.—Boyveau and Chevillet, Rue de la Banque, Paris. Chapelot and Cie., 136, Bld. St. Germain, Paris.
BELGIUM.—W. H. Smith and Son, 78/80, Rue du Marché-aux-Herbes, Bruxelles, and 44, Rue Joseph II., Ostend.
INDIA.—A. I. Combridge and Co., Bombay; Thacker and Co., Limited, Bombay; Thacker, Spink and Co., Calcutta.
ITALY.—Maglioni and Strini, 307, Corso, Rome; Fratelli Treves, Corso Umberto 1, 174, Rome; Fratelli Bocca, Rome; Ulrico Hoepli, Milan.
JAPAN.—Maruzen Co., Tokyo and Yokohama.
AFRICA.—Wm. Dawson and Sons, Limited, 7, Sea-street (Box 49), Capetown.
C. Juta and Co., Johannesburg, East London, and Grahamstown.
AUSTRALIA.—Gordon and Gotch, Limited, Melbourne, Sydney, Brisbane and Perth, &c.
Melville and Mullen, Melbourne.
Atkinson and Co., Gresham-street, Adelaide.
CANADA.—Dawson, Wm., and Sons, Limited, 87, Queen-street East, Toronto.
Gordon and Gotch, Limited, 132, Bay-street, Toronto.
Montreal News Co., 386–388, St. James-street, Montreal.
Toronto News Co., 42, Yonge-street, Toronto.
CEYLON.—Wijayarina and Co., Colombo.
JAMAICA.—Educational Supply Co., Kingston.
NEW ZEALAND.—Gordon and Gotch, Limited, Wellington and Christchurch; Upton and Co., Auckland; J. Wilson Craig and Co., Napier.
STRAITS SETTLEMENTS.—Kelly and Walsh, Limited, Singapore.
UNITED STATES OF AMERICA.—International News Co., 83 and 85, Duane-street, New York; Subscription News Co., Chicago.

Agents Abroad for Advertisements.

UNITED STATES OF AMERICA.—British and Colonial Press, Inc., 736, The Knickerbocker Building, 152, West 42nd-street, New York City.
FRANCE.—Agence Vox, 7, Rue de Surène, Paris (VIIIe).
BELGIUM.—W. H. Smith and Son, 78/80, Rue du Marché-aux-Herbes, Bruxelles, and 44, Rue Joseph II., Ostend.

SOUTH AMERICAN BRANCH OFFICE OF

The Engineer,

526, Bolsa de Comercio, Buenos Aires.

SUBSCRIPTIONS.

The Engineer can be had, by order, from any newsagent in town or country, at the various railway stations; or it can, if preferred, be supplied direct from this office.

Half-yearly (including index number) .. £1 12s. 6d.
Yearly (including two index numbers) .. £3 5s. 0d.

If credit occur, an extra charge of two shillings and sixpence per annum will be made.

Foreign Subscriptions will be received at the rates given below. Foreign subscribers paying in advance at these rates will receive The Engineer weekly and post free. Subscriptions sent by Post Office Order must be made payable to The Engineer and accompanied by letter of advice to the Publisher.

Thin Paper Copies.		Thick Paper Copies.	
Half-yearly	£1 11s. 6d.	Half-yearly	£1 13s. 9d.
Yearly	£3 3s. 0d.	Yearly	£3 7s. 6d.

(The difference to cover extra postage.)

Canadian Subscriptions—
Thin paper edition .. .. £2 18s. 6d. per annum
Thick paper edition .. .. £3 3s. 0d. "

*** Reading Cases, *to hold two copies of* The Engineer, *cloth sides and leather backs, can now be supplied at 4s. 9d. each, 5s. 3d. post free.*

ADVERTISEMENTS.

*** The charge for Situations Open and Wanted Advertisements of four lines and under is four shillings, and one shilling per line for each additional line up to one inch. When an advertisement measures an inch or more the charge is twelve shillings per inch. The rates for all other classes of advertisements, other than those mentioned above, are included in "The Engineer Directory," which is sent post free on application. All single advertisements from the country must be accompanied by a remittance in payment. Alternate advertisements will be inserted with all practical regularity, but regularity cannot be guaranteed in any such case. All except weekly advertisements are taken subject to this condition.

Small Advertisements cannot be inserted unless delivered before TWO o'clock on Thursday afternoon (the day before publication). ALTERATIONS to STANDING ADVERTISEMENTS must arrive not later than THURSDAY of the week preceding publication.

Letters relating to Advertisements and the Publishing Department of the Paper are to be addressed to the Manager, all other letters to be addressed to the Editor of The Engineer.

Postal Address, 33, Norfolk-street, Strand, W.C. 2.
Teleg. Address, "Engineer Newspaper, Estrand, London."
Telephone Nos. 2256, 2257 Central.

PUBLISHER'S NOTICES.

*** *If any Subscriber abroad should receive* The Engineer *in an imperfect or mutilated condition, he will oblige by giving prompt information of the fact to the Publisher, with the name of the Agent through whom the paper is obtained. Such inconvenience, if suffered, can be remedied by obtaining the paper direct from this office.*

TO CORRESPONDENTS.

*** *All letters intended for insertion in* The Engineer *or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

*** *We cannot undertake to return drawings or manuscripts; we must therefore request correspondents to keep copies.*

By arrangement with Reuter's Engineering Service, **The Engineer** *contains the latest news from all parts of the world which is likely to be of interest to engineers.*

Contents.

The Engineer, April 20th, 1923.	PAGE
The Lakeside Electric Power Station at Milwaukee. No. II. (Illus.)	409
Equivalent Loads on Bridges. (Illus.)	411
Corrosion of Metals	412
Australian Engineering Notes	413
Crossing the Sahara by Motor Car. (Illus.)	414
Steam Nozzle Research	415
The Engineering Association of Malaya	416
A Seven-day Journal	417
Double-headed Milling Machine for Scarfing Plates. (Illus.)	418
Development Works in North Island of New Zealand	418
Performance of Steam Wagons	419
Boosters for Locomotives. (Illus.)	419
Hardness Testing of Bearing Metals. (Illus.)	420
Railway Matters	421
Notes and Memoranda	421
Miscellanea	421
Leading Articles—	
Unemployment Insurance	423
Doubt and Research	424
British Engineering and the Chinese Market	424
Books Received	425
New Sewage Pumping Plant at Bognor. (Illus.)	426
The New Sentinel Steam Wagon. (Illus.)	427
The New French Navy	427
Electric Control Gear. (Illus.)	428
Letters to the Editor—	
Mechanical Gearing	428
Utilisation of Exhaust Steam in Locomotives	428
Design for an Express Locomotive	429
Hardness Testing	429
Pneumatic Drilling Machines. (Illus.)	430
Outdoor Switchgear. (Illus.)	430
Provincial Letters—	
The Midlands and Staffordshire	431
Lancashire	431
Sheffield	432
North of England	432
Scotland	433
Wales and Adjoining Counties	433
Launches and Trial Trips	433
Personal and Business Announcements	433
Current Prices for Metals and Fuels	434
French Engineering Notes	435
British Patent Specifications. (Illus.)	435
Forthcoming Engagements	436
Contracts	436
Paragraph—	
Faraday House Entrance Scholarships	433

THE ENGINEER.

APRIL 20, 1923.

Unemployment Insurance.

Within the last few days the Ministry of Labour has issued an important report on unemployment insurance. It is important because it presents, for the first time, a concise history of the events which have occurred since the passage of the Act of 1920, and particularly because it gives a general but effective survey of the problem of unemployment insurance by industries. Frankly, it is not encouraging. Like many another sociological catchphrase, "Insurance by Industries" looks extraordinarily attractive, extraordinarily simply, extraordinarily right. But when it is examined by cold logic, with a view to administration, the simplicity disappears and the justice and propriety of it are called in doubt. Its attractiveness alone remains and so desirable does it seem that in some way and by some means insurance against unemployment should be removed from the control of the State, as at present, to control by the people concerned—employers and employees—that one must go on hoping against hope that sooner or later a practicable scheme will be evolved, that sooner or later the vast difficulties which have so far overthrown every effort—save one—may be surmounted. There has, if we may say so, been too much readiness on the part of writers and speakers upon this scheme to look only at its attractive side and to avoid the dry but practical difficulties, and one of the great merits of the report before us is that, whilst it exhibits sympathy with the idea of insurance by industries, it shows the nature of the obstacles that have to be overcome before the ideal can be realised.

Under the Act of 1920, which came into force on November 8th of that year, compulsory insurance against unemployment was applied in industries employing some twelve million workpeople and employers. That Act followed out the principles of the Acts of 1911 and 1916, which affected in all only about three and three-quarter million persons. But it included a section—No. 18—of very great moment, for under it industries were empowered to contract out of the general scheme if they could present a special scheme which secured the approval of the Ministry of Labour. So great at that time was the favour in which insurance by industries was regarded that when the Bill was drafted little doubt was felt that great advantage would be taken of Sec. 18, and that under it a new era of unemployment insurance would open. Fate, so it is held—we know not with how much justice—overthrew those sanguine anticipations. The eagerness to adopt insurance by industries failed to manifest itself, and few schemes were presented to the Ministry for approval. Furthermore, the Ministry itself, embarrassed by the unexpected rise of unemployment in the spring of 1921, found itself obliged to withdraw "temporarily"—the embargo is still in force—permission to adopt special schemes, for it feared that any reduction in contributions to its general fund would plunge it still further into debt. The debt is, as a matter of fact, the report tells us, at this moment no less than sixteen million pounds. We have said that a single special scheme, a scheme for insurance by industry, has come to birth, and it may be well to state at once that it falls barely within the scope of what are familiarly known as industries. To the general mind, industries, with the exception of transport, are occupations of a productive kind, in which "labour" is employed. The one exception to which we have referred is the insurance industry, an industry which may be broadly described as clerical in character. It is worth noting, moreover, that the only other special scheme approved was submitted by the banking industry—another industry of clerical character. That scheme has so far made little or no progress towards adoption. In these two cases, and these two alone, has there been any serious attempt to apply the principles which have been so much belauded, and we cannot help noticing the significance of the fact that neither is what may be called a "labour" industry, an industry in the familiar sense of the word. The failure to secure practicable schemes is due to no indifference or supineness on the part of the Ministry of Labour, which, as a matter of fact, has made several efforts to encourage industries to study the problem. These efforts have not been very fruitful, except in the production of ephemeral literature, but as the report says, "It will be the duty of the Minister of Labour to collect and focus all relevant opinions and ideas, with a view to promoting the solution of what is admittedly a most complicated and perplexing, as well as a most important problem, and then to consider the further steps to be taken." At that we might leave the matter for the present, for since the embargo on the adoption of special schemes is still in force, and is not likely to be removed till the debt of sixteen million pounds has been paid off, there is no probability that insurance by industries can be extended for some years to come. But did we do so, we should leave our readers with a wrong impression of the position, and at the same time might encourage a lassitude which we little desire. It is true that but one scheme—that in the insurance industry—has come to fruition, it is true perhaps that but few definite plans have been submitted to the Ministry, but it is equally true that many special schemes were, up to the early part of 1921, examined by joint industrial councils, trade boards and associations of employers and employed. In most cases these inquiries did not proceed further than a preliminary inquiry, but they showed at least that a lively interest was being taken in the question, and though that interest was killed by the depression in trade and the enforcement of the "embargo," we may hope to see it in due time revived.

Profoundly as we hope that some means may be ultimately discovered of effecting insurance by industries, we cannot be blind to the significance of the events as they are detailed in this report. The Ministry places the cause of the paucity of special schemes in the great depression in trade, and absolves the embargo. "In all probability," it says, "very few new schemes (if any) would have been put into operation if the embargo had not existed." We find it difficult to accept that view, and still more difficult to agree that "the abnormal and almost universal unemployment was sufficient in itself to bring about the suspension of all proposals for special schemes." Men look for cures for epidemics when they are raging, and forget them when the sickness is over. Ever since the collapse of trade two years ago, the problem of unemployment has been kept constantly before the eyes of employers, and even allowing for the dulling and deadening effect of lack of occupation, we cannot believe that a subject so important, a subject which had attracted so much public attention, would have been neglected without some other and greater cause. That cause we find, first, in the embargo which postponed all schemes *sine die*, and, secondly, in the intrinsic difficulties presented by the problems of insurance by industries. Of these problems, by far the greatest is that of demarcation, and until it is overcome or circumvented, there is no probability of any schemes in the industries with which we are associated being realised. Note once more the significance of the fact that the one "industry" in which insurance has been effected is one wholly free from this particular problem. It is difficult to see how it can be

overcome. To narrow the basis of "industry" would be to cut the scheme up into parts so small that it would be economically unsound; to enlarge the basis is to increase the trouble, for in each collateral industry included new overlapping would occur. Thus do we appear to be upon the horns of a dilemma, and to be driven back on the national scheme with all its drawbacks and demerits. But so great is the desire, both on the part of employers and of labour, to effect insurance within industries, that despite the difficulties—which, as we have said, are very clearly set forth in this report—we are convinced that efforts will be renewed as soon as the removal of the embargo makes their adoption within reasonable time a probability. On the other hand, we can see little or no probability that schemes will be actively pursued whilst the Ministry of Labour can hold out no prospect of sanctioning them for perhaps years to come. In these circumstances, we suggest that the wisest plan would be to evolve at once some plan by which the embargo might be removed without adding to the present financial difficulty. If there is a way through the obstacles in the path of insurance by industries, it will then be found; but it will not even be sought whilst the finding of it can lead to no immediate results.

Doubt and Research.

The division of opinion on the question of engineering research is apparently no less marked in America—where industrial research is carried on to an extent almost unknown in this country—than it is here. Thus we find on one side those who believe that any kind of research is worth while, since history shows that the useless knowledge of one age is often the utilitarian of the next; and on the other side we have those who protest against the expenditure of public money on pure science, and insist that engineering research should always be directed towards some end of immediate value to the community. The difference is one that will never be removed, because both sides can with ease advance argument after argument and instance after instance to support their opposing causes. One may point to the pure science of Faraday and another to the utilitarian research of Edison; one to the industrial investigations of the General Electric Company, and the other to the theoretical researches of the Royal Institution. The fact that such marked differences of opinion exist and are so readily supported leaves to our mind no doubt that both kinds of researches are necessary, and that the condemnation of either shows a lack of perspicacity. Yet we confess we appreciate the danger of a too-ready commendation of abstract and vague research. It is fatally easy for a young man to drift into that kind of work and to defend it on the ground that any knowledge is good, and that the work of a score of famous men in abstract science shows that any discovery may lead to a useful end. Against that easy course we must defend ourselves, and the best method of so doing is to have always some definite useful object in view. Young men will do well to remember that the chances of collateral discovery are always just as great in industrial as in "pure science" research. The discovery of the properties of chromium in steel by Brearley or of the incandescent mantle by Wellsbach may be given as examples, but industrial history contains many such.

Ignorance of our ignorance is the most powerful of all causes producing stagnation in science, pure or applied. It is impossible to say by how much progress has been arrested by authority, but there can be no manner of doubt that men may easily build out of preceding knowledge a barricade against their own advancement. Hence scientific scepticism is an attitude of mind to be cultivated, and, we suggest, that on this account the care to prevent overlapping of research should not be pushed too far. In the past, engineers have been relatively little influenced by scientific theories, and it is not impossible that because of that indifference they have continued to advance when the science of the day told them further progress was impossible. There is no test-house in the world half so good as the competitive market, and the manufacturing engineer has his samples and test pieces continually in it. It searches out the weaknesses, exposes faults, exhibits inefficiencies, and impels the manufacturer to hunt for improvements and find them even in defiance of the pundits. It provides him with that stimulus to research which would otherwise be lacking; it prevents him from falling into the easy belief that he is doing all that is mortally possible, and that no more can be expected from him. The purchaser always expects more; he knows nothing about scientific causes, and will not "listen to reason," and in the end he gets his way, to the lasting benefit of engineering. He compels the engineer, despite himself, to question his own knowledge. "Engineering work," said Mr. F. E. Schmitt, associate editor of *Engineering News-Record* in a debate before the American Society of Civil Engineers, "is essentially a matter of working with tools that we have and that we consider satisfactory, and the common attitude of the practising engineer toward his work and his problems is that the means at hand are ample—he is bound to take that view, or he cannot have confidence in the results of his work. *The beginning of research is doubt as to whether our available means are ample.* It is difficult for engineers to put themselves into that doubting frame of mind, and we must charge to this phase of the matter—in part at least—the difficulty of collecting the problems which face every engineer in his work, and of bringing them to a focus so that research can begin." That is an admirable point admirably put. Mr. Schmitt was speaking primarily of civil engineering in which the competitive influence is not so powerful as in mechanical engineering, but we agree with him that even in mechanical engineering, though in a less degree, it is difficult for engineers to put themselves into the doubting frame of mind which is, as he says, the beginning of research.

It will not be supposed for one instant that we have the slightest desire to disparage the work of the great men who have built up the practice and science of engineering when we urge the necessity of continually questioning their dicta. They expressed the best knowledge of their day and we honour them for it, but we must not forget that, often enough they themselves made discoveries and effected progress by doubting the authorities who preceded them. In that we are wise to follow them. They were great because they were exceptional. They tried to do things that others regarded as folly; they flew in the face of current knowledge—and succeeded. All too often, as history shows, the bonds of tradition have been too strong for those engaged in the industry, and the bar to further progress has been broken down by someone outside it—men like Armstrong the lawyer or Fulton the painter. If that is less likely to happen nowadays than in times when engineering offered easier opportunities, yet the danger that we may overlook improvements through over-confidence and through ignorance of our own ignorance still exists, and it is still as necessary as ever that all—save the youngest—should doubt all things; prove all things.

British Engineering and the Chinese Market.

There are many indications that renewed interest has been aroused among British manufacturers in the possibilities of China as a market for engineering products. To those people who are well acquainted with this great country and have watched the steady growth of its industries and the annually increasing volume of its foreign trade, such a manifestation is specially welcome. It signalises, perhaps, the end of a long period when, during the heyday of British overseas prosperity, China had come to be regarded as a veritable Cinderella among the markets of the world. For many years a strenuous and uphill fight has been waged by Commercial Counsellors, special commissioners, and publicists to dispel apathy and stimulate enterprise in this direction, but with little more than sectional success. Indeed, it is very doubtful whether the present interest would have arisen had it not been for the coincidence of market dislocation in countries nearer home. It is this last circumstance, mainly, that has inclined the manufacturer to look farther afield and to pay some attention to regions where economic reaction to the European upheaval is least apparent. Thus China comes to-day within the business purview of British industrialists generally, and inquiries are multiplying as to the right methods to be adopted in order to secure a profitable return from that market.

It is unfortunately true that while an almost complete lack of knowledge in regard to China is characteristic of our manufacturers, very little real practical information is available to them in England. To state this is to cast no reflection upon the excellent services of commercial intelligence maintained by such institutions as the Department of Overseas Trade, the Federation of British Industries, and the British Engineers' Association. These essential organisations can, and do, accomplish a great deal not only towards keeping alive an interest in the trading possibilities of China, but also in rendering extremely valuable assistance and advice to firms dealing in that market. Their sphere of usefulness is certainly not likely to disappear during the present commercial generation. Nor is any taunt implied in speaking of the prevailing lack of knowledge in regard to China. How, without actual experience, can anyone possess real knowledge of a country so remote as China is from England, of such vast continental dimensions, containing such an enormous population, and remarkable for its strange customs and conditions so utterly unlike anything to be met with in the West? The phenomenon becomes more explicable when we bear in mind that even among the several thousands of Britons residing in China only a relatively small number are, by training and experience, capable of wide observation, reasoned deduction, and sound practical advice in respect to many vital trade matters. The truth of this statement is borne out by the fact that the far greater proportion of Britons who proceed to China are obliged to confine their energies to a particular groove and to remain rooted to a particular centre throughout the whole of their stay in the country. Those few men who do possess the requisite experience employ it almost exclusively, as is only natural, in furthering the interests they serve, and consequently do not contribute directly to the sum of expert knowledge available to the general inquirer in Great Britain.

The inevitable conclusion is reached, therefore, that in order to obtain a proper grasp of the peculiar difficulties confronting trade in China and to devise a practical means of overcoming them, it is necessary for the manufacturer to institute a thorough investigation in the market itself. Such investigation, it need hardly be added, would apply only to those lines of manufacture for which a demand exists or could be created, and in respect to which present selling methods are capable of considerable improvement. Even this qualification presupposes the possession of certain preliminary data on the part of manufacturers; but where they are lacking, they should be readily obtainable through the Commercial Intelligence organisations already referred to. In cases where investigation might be considered too costly an undertaking for an individual firm, there is no reason why the work should not be carried out by a small, though suitably selected and non-competing group of industrialists formed for the purpose.

It may perhaps be of interest to turn to the market itself and consider very briefly certain general aspects in relation to existing channels of trade, since these channels would have to be explored with close attention paid to their true economic utility as distributing media before any investigation into market conditions could be complete. Where the value of their commercial functions could be satisfactorily established, such channels would have to be carefully examined with a view not only to ascertaining their carrying capacity, but also to estimating the extent of the market territory it would be possible for them to serve.

It would be discovered that the British *bonâ fide* merchant houses may, for all practical purposes, be subdivided roughly into two classes: (*a*) the general import and export merchant specialising in engineering plant and material; and (*b*) the merchant trading exclusively, or mainly, in these lines. Taking both classes into consideration, there are to be found among them a range of firms differing widely in essentials, such as financial strength, spheres of activity, and methods of operation, all of which are matters of peculiar interest to the manufacturer. The greatest aggregation of merchant houses is based on Shanghai, the pre-eminence of which port as a first distributing centre—because of its foreign (non-Chinese) administration, its banking facilities, and its geographical situation—is not likely to be challenged for many years to come. In the South, Hong Kong is the distributing centre; but apart from the large and growing requirements of the British Crown Colony itself, this part of the country, though the trader cannot afford to neglect it, does not at the present time compare with mid-China and the North as a market for engineering products generally. The most influential among the first type of Shanghai firms, namely the general merchants, have their own branch or parent organisations established in Hong Kong, as well as their branches in other commercially strategic centres, such as the Treaty Ports of Hankow, Tientsin, &c. &c. There are, however, exceedingly few of this type of firm, and actually none of the second class mentioned, that maintain establishments in more than one or two centres in China. On the other hand, in a number of the Treaty Ports, and particularly in Shanghai, many purely local British firms are trading.

It will readily be understood, therefore, that with a few conspicuous exceptions it is out of the question for individual merchant firms in China to afford, in the territorial sense, really far-reaching services to British manufacturers. With regard to the exceptions—the few general merchant firms possessing widespread organisations and specialising in engineering products—it will be obvious that at any given period there must be a limit to the number of manufacturers for whom they can render services under sole agency conditions.

Even, therefore, if the placing of agencies were the sole vital consideration of British manufacturers in their efforts to secure an adequate share in the trade of China, the problem is shown to be sufficiently complex to call for data that are not procurable without a certain amount of investigation. When it is remembered that in placing a sole agency a manufacturer

definitely regulates his sales throughout a given territory for very appreciable trading periods at a time, it becomes most desirable that as a principal to such an arrangement he should enter into it with his eyes open. But how can this be if negotiations are conducted exclusively by letters and telegrams between sales management in England and agent in China? Even on those occasions where the potential agent or his representative happens to be paying a visit to this country, while certain advantages cannot fail to arise from the circumstance, there is as a rule between the manufacturer and himself far too great a disparity in regard to knowledge of local market conditions to ensure that negotiations shall lead to a really equitable and efficient working arrangement that is likely to give sustained satisfaction to both parties. There are many ways in which a China merchant can acquaint himself with essential data respecting a manufacturer and his products. But usually the latter is not so happily placed concerning the merchant and his activities.

The problem of distribution in China, however, cannot be solved out of hand by merely concluding an agency agreement with a British merchant house and leaving it at that. Much more remains to be done by the manufacturer if he intends to secure business and to establish a satisfactory goodwill in this market. How important it is to realise in this connection that except for the functions exercised by the foreign (non-Chinese) importer and the Exchange Banks in the Treaty Ports—microscopic spots in these vast and densely populated dominions—China provides none of those familiar facilities that are inseparable from the trading mechanism of highly organised markets, and have simplified the conduct of international commerce. On the other hand, the very conditions that are peculiar to the country, such as inadequate communications, the language difficulty, complex currencies, an almost universal ignorance of Western business methods, strange customs and usages, and a conservatism that is amenable alone to direct demonstration and appeal, impose obstacles that can only be surmounted by persistent and painstaking effort in the field itself. But is it either reasonable or desirable that this effort should come solely from the merchant or agent established in China? In a market such as this, where demand must be cultivated energetically, these firms, by whose enterprise alone Great Britain's trade with China has been built up in the past, cannot be expected, to expand their organisation indefinitely to meet the urgent requirements of a national industry that has been cut off from many of its best customers. In any case their selling activities are bound to be limited by the necessity for having to show a profit over operating costs, competition among the merchants themselves acting, of course, as a check on the margin of profit available. Furthermore, taking the whole range of his activities into consideration, the merchant cannot on logical grounds be expected to accomplish in the China market more, in proportion, than the distributor in the home market. Yet, in order to compete in the highly organised home market manufacturers are very often obliged to equip elaborate sales organisations involving very appreciable charges, and to maintain advertising departments, for the purpose of stimulating sales through distributors as well as direct.

With regard to a varied range of manufactured products, a great deal could be accomplished by manufacturers setting up their own sales organisations in China, where, through being established in the market, they could select from existing firms, both native and foreign, the most advantageous distributing media throughout the country. Such organisations would provide technical service where necessary, and if properly planned, and operated efficiently, should largely increase the manufacturer's business and become self-supporting within a very short period. Taking into consideration the engineering trade generally, however, what is urgently required is a much greater measure of active co-operation between the manufacturer on the one hand and merchant organisations in China on the other. Special investigation alone can satisfactorily decide as to the desirability of the separate organisation and the actual method of co-operation referred to. There is no royal road to successful trading in China accessible to all classes of trade or even to all kinds of products among the engineering class. Investigation of methods and conditions of trade in this market would reveal conspicuously successful examples of co-operation between manufacturer and merchant in many lines. In some instances it would be possible to adopt similar procedure; in others, while accepting the main principles, to depart from the strict methods of these precedents.

Nor would careful investigation fail to discover in several directions examples of manufacturers' representative organisations that have disappointed the expectations of their founders. In these cases the original fault would be found in the startling circumstance that formation had been brought to the stage of accomplishment without any proper realisation on the part of manufacturers of actual conditions obtaining in China. Thus, in one or two instances a preconception based on conditions ruling in markets differing in every essential from China would seem to have dictated the constitution adopted and the policy pursued. In others, judging by the long lists of associates, numerical and therefore subscribing strength would be revealed rather than a discriminating selection based on actual trade requirements. Here in regard to many of the lines represented it would be apparent that the maximum demand formed only a very small volume of the trade of China; that they could not be operated unless they possessed a separate working entity in the market; or that the goods, having a market price independent of the cost of manufacture, should only be sold without restriction—*i.e.*, that they should not be confined to a single selling organisation but sold through the open market. It would be discovered that the outstanding mistake made in all these cases had been to ignore the true functions of the *bona fide* merchant with whom such organisations, while asserting their liberty to deal direct throughout the market, desired to do business, and by whom they were regarded as competitors. Although it is not necessary to describe in detail the working defects of these representative organisations, it will be as well to emphasise their inherent inability to finance their own business as well as the inveterate coldness in the attitude of the merchant towards them, in order to demonstrate the danger of manufacturers deciding upon a policy in regard to China without first having instituted in the country itself the most searching inquiries on their own account.

Any serious business investigation in China presupposes, in principle at least, the intention of the manufacturer or industrial group to give effect to whatever practical recommendations may be forthcoming. Therefore it will perhaps be of interest to mention that existing methods of co-operating with merchants in China, which have shown successful results, include the following arrangements:—

(*a*) Manufacturers' experts are attached to the merchant firm—in the pay of the former and sometimes under the discipline of the latter. Stocks are carried by the merchant for the manufacturer's account. While the merchant guarantees eventual payment, the manufacturer assists in financing contracts involving deferred payments. The merchant's guarantee in this respect enables the manufacturer to obtain ready facilities from the banks.

(*b*) Independent manufacturers' representative organisations to which technical experts are attached.

In both cases the experts acquire a working knowledge of the Chinese language, and it is their duty to seek for business and to render technical service to buyers—the latter being a very important consideration. With regard to the representative organisation, this is in effect an extension to China of the manufacturer's home sales organisation. In such cases there is no attempt to usurp the functions of the merchant. While business is actively sought, sales are not made direct to the Chinese, but where orders are taken they are placed through a merchant house. Such organisations are not unwelcome to the merchant who prefers to deal with his own inquiries on the spot rather than having the trouble, delay, and expense, often with unsatisfactory results, of cabling or writing to England. It may be mentioned that where sufficient business can be found an organisation of this kind provides a satisfactory means of operating, among other lines, those products in demand that cannot be suitably handled as sole agencies by the merchant. Obviously in cases of this description, the manufacturer is not tied to a particular merchant, and business comes to him, or is sought, through many business channels, British and otherwise. Consequently, it is clear that by operating in this way not only would those manufacturers for whom it constitutes the right method obtain a share of the existing volume of trade that otherwise would go past them, but through their local efforts in this rapidly developing market they would benefit by opening up entirely new business.

In determining the right methods to adopt in order to obtain the maximum sales turnover in particular lines in China, investigation should cover the entire process through which goods pass from their despatch ex-factory to their delivery to the final purchaser. With regard to many manufactured products, in other words, it is not sufficient to base conclusions exclusively on data conscientiously gathered in the market itself and relating to the means and costs of actual distribution, essential though such data is to a solution of the whole problem. The important consideration of manufacturer's price enters into the question. For example, it is a common practice for manufacturers to give an appreciably better discount to the oversea than to the home distributor. In some few cases this practice does amount to a generous concession, while in all cases it implies, theoretically at least, some recognition of the factors of competition, and distribution costs, in overseas markets. But it should be borne in mind that these foreign discounts are, in reality, determined not on the selling requirements and conditions of particular markets, but on the margin of economic ability with which manufacturers decide individually, after weighing up their own financial position, they can meet competition generally in the markets of the world. In the majority of such cases as we are considering, therefore, the foreign discount quoted is an invariable figure applying to all overseas markets. Yet one of the most elementary truths in regard to foreign commerce is that selling costs vary considerably as between market and market. In this respect it is questionable whether the highest selling costs in any country can compare with those obtaining in China. To meet competition in this market, therefore, and to secure the maximum volume of business it is very desirable that the most serious consideration should be given by manufacturers to the question of net price. As matters stand, the invariable net price quoted to overseas buyers includes a very considerable percentage over and above the figure that would return the requisite profit on manufacture itself. This additional percentage represents an appreciable share of the cost of maintaining the manufacturer's own selling organisation in Great Britain. Yet it may be taken for granted that in most instances one of the first conclusions arrived at as a consequence of a thorough investigation such as we are supposing, would be that as a means of developing a really satisfactory trade with China no dependence can be placed on the home selling organisation however efficient it may be in its business with other markets. This statement does not err by a hair's breadth on the side of exaggeration; and when a close study of all the complex conditions of the market has been made on the spot the manufacturer will realise the impossibility of conducting his business in China from a distance of 12,000 miles.

To sum up, whatever may be the requirements of other markets, the necessity is clearly indicated for a marked differentiation in sales policy so far as China is concerned. Actual *modus operandi* can only be determined after special investigation. But while for China, methods of a special character ought to be adopted if success be the objective, it should not be difficult for manufacturers who realise the potentialities of this market to reconcile the necessity for such methods with the requirements of their overseas interests as a whole.

It only remains to be added that the present time is opportune for carrying out investigation in China. At the moment it is true that factional dissension is rife. The Central Government is without effective authority, and the national exchequer is empty. Business men in China, however, who are watching developments closely are laying their plans in view of the probability that a decided improvement in State affairs will take place after the sanctioned increase in Customs duties becomes operative and provides the Government with much needed funds. Meantime, while existing conditions have an adverse effect on purchases for the maintenance and extension of the railways, and have called a halt to other State enterprises, the ordinary trading life of the nation is as robust as ever. Communications here and there become dislocated, fighting in circumscribed regions breaks out periodically; but the great mass of the Chinese people throughout the great bulk of the Chinese dominions continue to buy and to sell as they have done for thousands of years. To complete the paradox, while the State coquettes with bankruptcy, the country itself is as abundant in money as it is rich in resources, industrial development proceeds apace, and foreign trade increases with steady and substantial ratio year by year.

BOOKS RECEIVED.

Report on the Progress and Condition of the United States National Museum for the year ending June 30th, 1922.

The British Coal Mining Industry during the War. By Sir R. A. S. Redmayne. Oxford: The Clarendon Press.

X-Rays. By G. W. C. Kaye, D.Sc. London: Longmans, Green and Co., 39, Paternoster-row, E.C. 4. Price 30s. net.

A Text-book of Ore Dressing. By S. J. Truscott. London: MacMillan and Co., Limited, St. Martin's-street, W.C. 2. Price 40s. net.

Gasholder Design and Construction. By R. J. Milbourne. London: Walter King, Limited, 11, Bolt-court, Fleet-street, E.C. 4. Price 10s. 6d.

The Modern Ironfoundry. By Joseph G. Horner. London: Henry Frowde and Hodder and Stoughton, 1, Bedford-street, W.C. 2. Price 15s. net.

Printing Telegraph Systems and Mechanisms. By H. H. Harrison. London: Longmans, Green and Co., 39, Paternoster-row, E.C. 4. Price 21s. net.

Atoms. By Jean Perrin; authorised translation by D. Ll. Hammick. London: Constable and Co., 10–12, Orange-street, W.C. 2. Price 8s. 6d. net.

Indian Engineering. By W. L. Strange. London: George Routledge and Sons, Limited, Broadway House, 68–74, Carter-lane, E.C. 4. Price 12s. 6d. net.

Wireless Component Parts and How to Make Them. By Bernard E. Jones. London: Cassell and Co., Limited, La Belle Sauvage, E.C. 4. Price 1s. 6d. net.

The Mechanisms of Machine Tools. By T. R. Shaw. London: Henry Frowde and Hodder and Stoughton, 1 and 2, Bedford-street, W.C. 2. Price £2 2s. net.

The Prevention of Vibration and Noise. By Alec. B. Eason. London: Henry Frowde and Hodder and Stoughton, 1, Bedford-street, Strand, W.C. 2. Price 15s. net.

A Tested Method of Laboratory Organisation. By Seymour Pile and Reginald Johnston. London: H. F. and G. Witherby, 326, High Holborn, W.C. 1. Price 7s. 6d. net.

Henslowe's Motor Dictionary: English-Spanish, Spanish-English. By Leonard Henslowe. London: Hirschfield Bros., Limited, 263, High Holborn, W.C. 1. Price 5s. net.

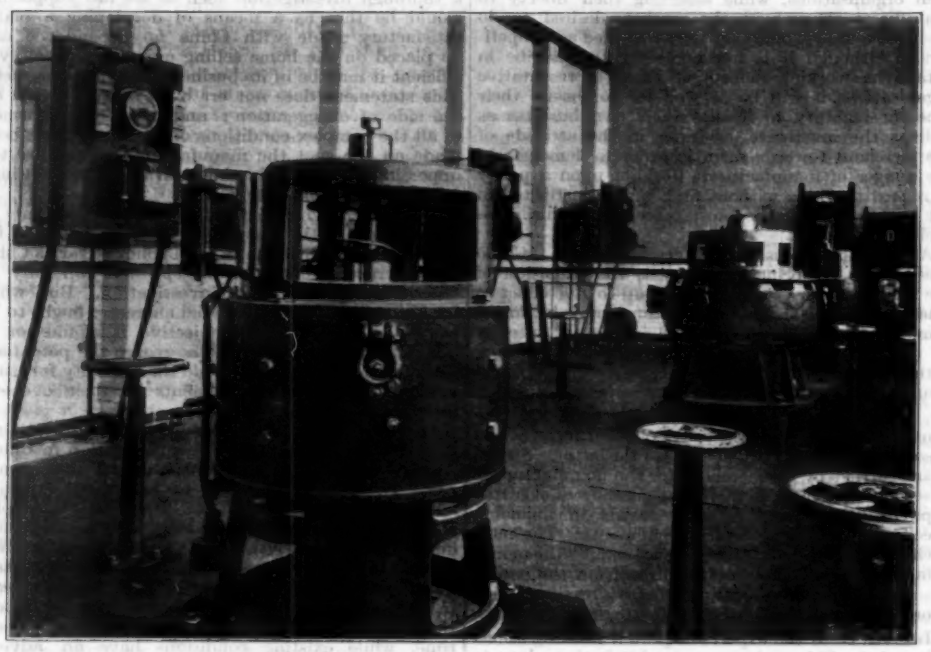
A Comprehensive Treatise on Inorganic and Theoretical Chemistry. Vol. III. By J. W. Mellor, D.Sc. London: Longmans, Green and Co., 39, Paternoster-row, E.C. 4. Price 63s. net.

New Sewage Pumping Plant at Bognor.

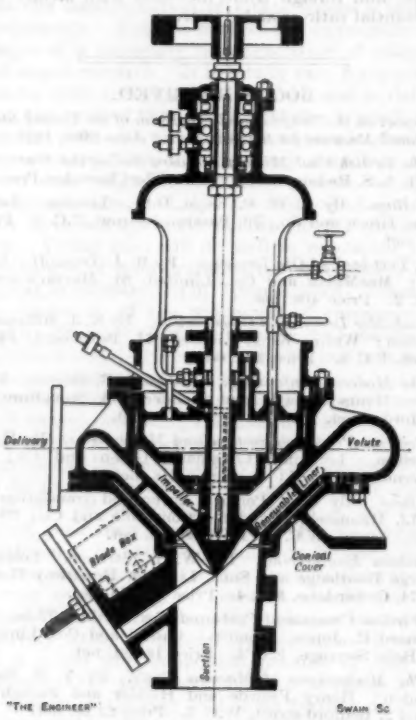
THE growing popularity of Bognor as a health resort, and the consequent demand of the district for a sewage disposal scheme of increased capacity, have led the Urban District Council to undertake the works, of which the following article is a brief description. Before the starting up of the new plant the sewage of the town—a matter of 350,000 gallons daily—flowed by means of an egg-shaped brick sewer of large capacity into a tank capable of holding about 300,000 gallons when filled to a level of 13ft. above sea-level at low tide. There it was allowed to collect until such time as the tide should have fallen low enough to allow the head of the liquid in the tank to open the tidal flaps, so that the sewage discharged itself into the sea by gravity, at a point 230 yards from the sea wall at low-water mark.

It was found, however, that under certain circumstances the returning tide was slightly tainted with sewage, and in view of the number of bathers among the visitors to the town, it was decided that some other system must be adopted. Accordingly, the Council consulted Mr. E. J. Silcock, M. Inst. C.E., who recommended that a new sewer, which would discharge into a new tank at a lower level, should be laid, and that the sewage should be pumped from that tank to the existing tank and thence into the sea through a discharge pipe about 800 yards long, and delivering with 12ft. of water at low tide. It was recommended, too, that the pumping should be carried out during the period between one hour before high tide, and one hour before low tide, it having been found by means of experiments with floats that such a course would ensure that none of the suspended matter would be washed ashore. A further improvement would result from the fact that, except in the case of exceptional rain storms, the sewers in the town would never be full, as was formerly the case, when they were used virtually as storage tanks.

The construction of the new tank, pump-house and wells, and the excavation for and laying of the pipes, were carried out by Messrs. Tom Wilkinson and Co. The work was exceedingly difficult owing to the shifting nature of the ground, which consists of a mixture of sand and mud on a substratum of clay. The excavations being at a distance of not more than 100ft. from the shore, there was also considerable difficulty in combating the inflow of water. Work on the tank was begun in August, 1921, and was completed in August, 1922. The tank is 30ft. deep by 84ft. by 50ft., and is constructed throughout of concrete strongly buttressed and stayed, with a reinforced concrete roof covered with 4ft. of soil to weight the floor against upward water pressure. The bottom, which has a fall of 6in. in its length, drains down to a sump 5ft. wide along the seaward edge, into which project three pump suction pipes. Adjoining the tank on its seaward side, and of an equal depth, are three pump wells, only separated from the tank itself by a concrete partition wall, while above them is the motor house—a rough-cast brick building. The level of the pumps is thus so arranged that they are self-priming.



INTERIOR OF SEWAGE PUMPING STATION AT BOGNOR



VERTICAL TYPE OF STEREOPHAGUS PUMP

The pumps, which were designed and made by Hathorn, Davey and Co., Limited, of Leeds, are of that firm's vertical spindle stereophagus type. They are arranged at the bottom of the pump wells, and are driven through vertical shafting by electric motors, manufactured by Laurence, Scott and Co., Limited, of Norwich. These pumps, which are illustrated in the accompanying engravings, are, we are given to understand, the largest of their kind in existence. The stereophagus pump, which, as our readers will remember, was the invention of the late Hon. R. C. Parsons, is designed to deal with sewage or other fluids, together with any solids, whether of a fibrous or gritty nature, which they may contain. It is a centrifugal pump of the single-stage type, the impeller of which, instead of being of disc form, is made conical. Its spiral blades, which are open on one side, make a running joint with the conical cover, the wear being taken up by a simple mechaoical adjustment. In one with the cover is a chamber in which is inserted an adjustable steel knife having a sloping edge set close to the vanes of the impeller, which latter, by passing its edge obliquely, slice any solid bodies entering the pump after the fashion of the Archimedean lawn mower. Axial-balance is obtained for normal head as follows:—Four radial blades on the back of the impeller maintain a ring of rotating water of a thickness just sufficient to balance the head at the tips of the spiral blades. Atmospheric or suction pressure is then admitted inside this ring so as just to eliminate end thrust.

Of the three pumps at Bognor, two are designed to deliver 1500 gallons per minute, and one 3000 gallons per minute, of unscreened sewage, against a static head of 20ft. The conditions further require, however, that the pumps shall be capable of operating against any head between 3ft. and 30ft., the quantity, of course, varying conformably. The normal running speeds of the small and large pumps are 400 and 320 revolutions per minute respectively, but a variation in speed is provided on the motors to 450 and 380 revolutions per minute, in order to provide for the greatest heads. Small auxiliary suctions are fitted on the pumps to drain the pump wells.

The motors, which are of the direct-current, compound-wound type, work at a pressure of 440 volts, current being supplied by the Bognor Electric Lighting Company. They are controlled by a system of float-operated tappets in such a manner that the two smaller units are successively started as the level in the suction tank rises, the large pump only operating in case of emergency. By throwing over a selector switch, either of the smaller pumps may be made to come first into operation, so that the wear on the two sets may be equalised. The two pumps are knocked off when there is about 1ft. of sewage in the tank, but the large unit is made to run a little longer in order that the normal operation of the small pumps shall not throw it out of action. Thus the large pump may be started up at any time from the engine-house should the flow for any reason gain on the smaller pumps.

Tests were carried out on site over the greatest range possible with the quantity of sewage available, and for periods of 55 min. in the case of the large pump, and 1 h. 20 min. in the case of each small pump. The results are set out in the accompanying tables. All the heads given are static, no allowance being made for the friction through three sluice valves, three bends, one tee, one non-return valve and a considerable length of piping. The quantities were measured by means of the levels of liquid in the suction tank, which was calibrated. The efficiencies given are overall and include losses in pumps and motors and also the hydraulic frictional losses.

12in. Pump.

Duty: 3000 gallons per minute at 20ft. head, and to pump at any head between 3ft. and 30ft.

Speed.	Static head.	Quantity g.p.m.	Water H.P.	Elec. H.P.	Efficiency. Per cent.*
279	6.7	3620	7.36	27.2	27.0
291	8.6	3077	8.02	27.0	29.7
298	10.5	3236	10.28	26.9	38.2
306	12.2	3500	12.94	36.8	35.2
343	14.1	3568	15.25	39.7	38.4
348	15.8	3370	16.14	39.3	41.1
350	17.2	3100	16.15	40.5	39.9
366	19.2	3120	18.13	40.0	45.4
364	20.4	2818	17.40	38.6	45.1
364	21.8	2685	17.74	37.0	47.9
371	23.3	2640	18.61	42.9	43.5
384	22.3	2790	18.84	44.5	42.4

* Arrived at by dividing the weight of crude sewage raised by the electrical input.

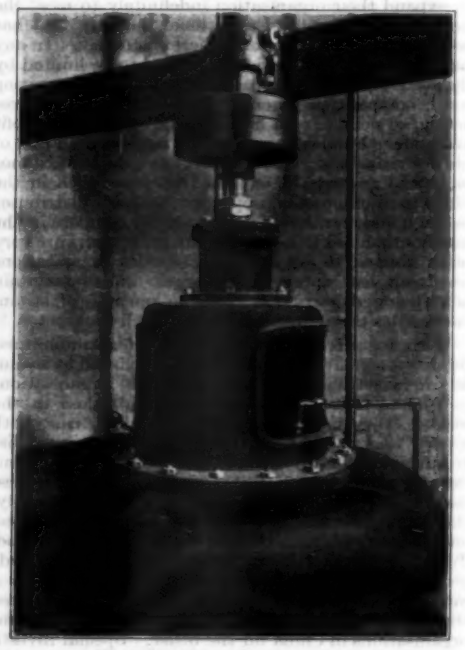
10in. Pump.

Duty: 1500 gallons per minute at 20ft. head, and to pump at any head between 3ft. and 30ft.

Speed.	Static Head.	Quantity g.p.m.	Water H.P.	Elec. H.P.	Efficiency. Per cent.*
397	5.6	2550	4.33	24.0	18.1
404	8.7	2283	6.01	24.7	24.3
400	11.3	2224	7.61	24.8	30.8
404	13.7	2118	8.79	25.0	35.1
413	15.8	1940	9.30	25.2	36.9
417	17.9	2020	10.96	25.7	42.6
415	19.6	1752	10.40	25.9	40.2
417	21.3	1589	10.24	25.3	40.5
424	(23.3)	1660	11.72	24.7	—

* Arrived at by dividing the weight of crude sewage raised by the electrical input.

These tests show that the efficiency of the stereophagus pump, though somewhat less than that of a first-class centrifugal pump of the ordinary type when first installed,



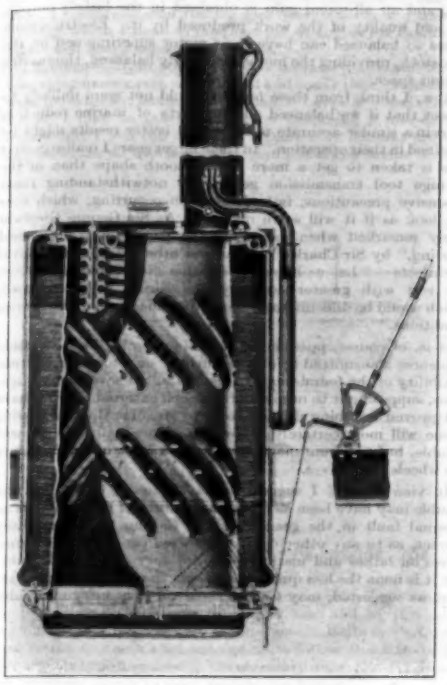
STEREOPHAGUS PUMP IN WELL

does not lag far behind it. In the present instance, the contractors calculate that taking account of electrical losses and making a conservative allowance for the head lost in friction, the net efficiencies, when pumping crude sewage, of the small and large pumps work out at about 53 and 58 per cent. respectively.

A STATION with six platforms and a covered way direct into the Exhibition grounds, within sight of the great Wembley Park Stadium, has been built by the Metropolitan Railway. Day and night for weeks past an army of bricklayers, carpenters, and steel workers have been racing against time to ensure that the station shall be in readiness for the Cup Tie Final, and the result is a most efficiently equipped station for the accommodation of large crowds and rush traffic. The station buildings are substantially constructed of red and blue brick. Nineteen booking windows have been provided to deal expeditiously with return traffic. Up-to-date all-electric signalling is being installed, and this, coupled with an ingenious track lay-out, will facilitate the handling of abnormal traffic. Trains will arrive every 1½ min., providing for more than thirty thousand passengers per hour. The journey time of the fast trains to and from Baker-street has been reduced to 10 min.

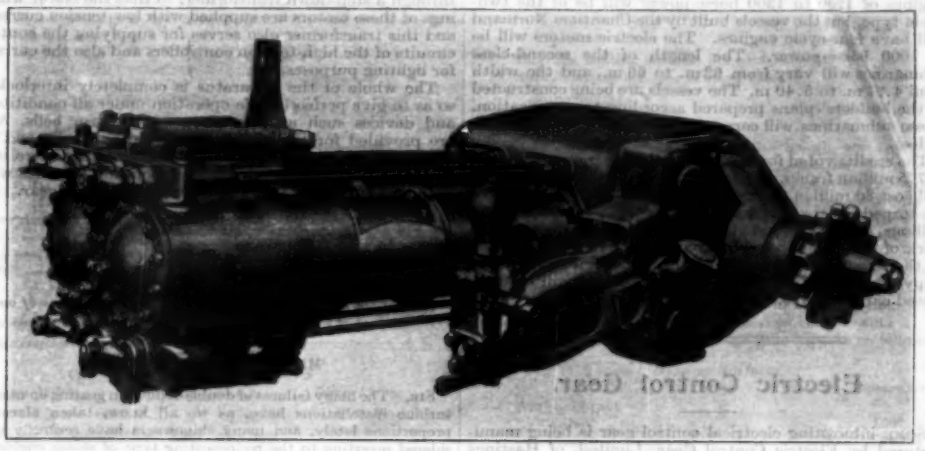
The New Sentinel Steam Wagon.

THE Sentinel steam wagon has been on the market since 1906. It was originally made by the firm of Alley and McLellan, Limited, Glasgow, but in 1915 a new works was built at Shrewsbury, which was taken over in 1917 by a separate and independent company with the title of the Sentinel Waggon Works, Limited. Under the new company the output of these vehicles was greatly increased and their popularity was justified by the excellence of the workmanship and design which was put into them. Although the wagon has always maintained its prominent position amongst vehicles of a similar class, the builders have for the past five years been making careful and exhaustive experiments and tests with the object of producing an even better machine with certain important novel features. We recently had an opportunity of inspecting one of these improved wagons, as well as the process of construction at the works at Shrewsbury, and were impressed by the design of several of the essential parts, such as the engine and boiler, illustrations of which are given above. The methods of construction, the testing of the materials employed and the general equipment of the workshops are admirable.



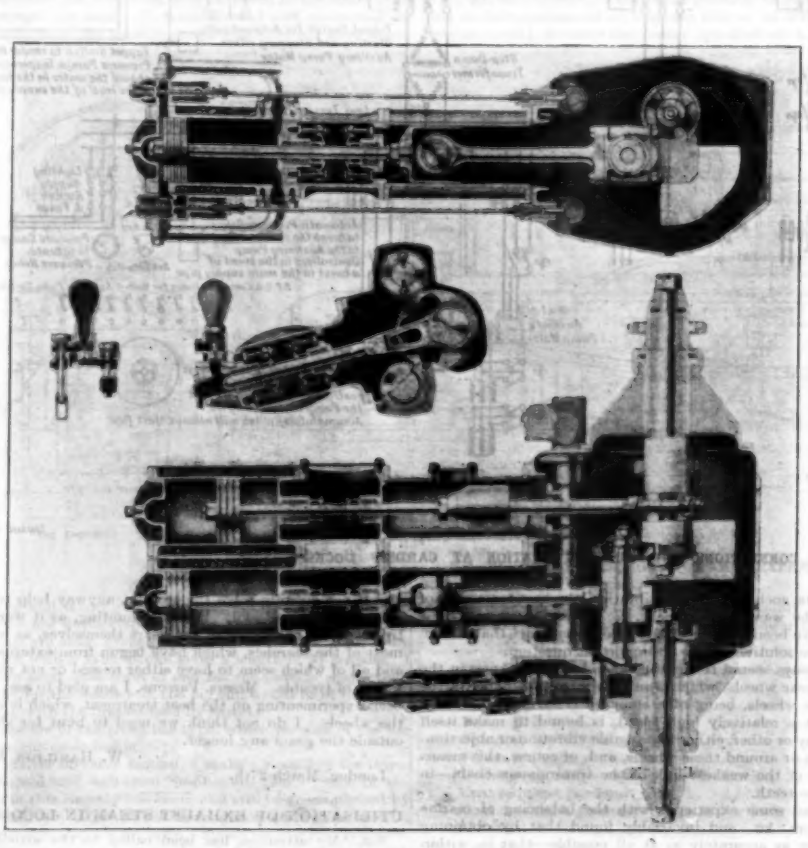
NEW SENTINEL BOILER

The most marked development is in connection with the engine, which has the differential gear in the crank case. It, in fact, now forms part of the crank shaft, enabling the designers to do away with lay shafts and provide a rigid stationary back axle, while housing the differential gear so that no road dust can find access to it. Incorporated with the differential crank axle is a friction drive, which prevents the differential from operating until there is 10 to 15 per cent. difference in the tractive effort of the two road wheels. The heavy crank shaft has two cranks at right angles, and is bored through its entire length to accommodate at either end the floating shafts which transmit the power to the chain sprockets, which are mounted on either end. On the inner end of each floating shaft a gear wheel is rigidly secured, which meshes with a pinion cut from the solid bar in a shaft housed inside either crank pin, the inner ends of these crank pin shafts carrying gear wheels which mesh with one another, thus forming a differential train. In this way, assuming the crank shaft to be stationary and one of the sprockets turned in a clockwise direction, the crank pin shaft will be caused to turn anti-clockwise, causing the other crank pin shaft to turn in a clockwise direction, and the far side pinion to turn in an anti-clockwise direction. In the centre pair of gear wheels two cone clutches are provided, being held in engagement by means of springs, and these are so adjusted that a predetermined amount of resistance has to be overcome before any wheel of the differential train can move independently of the crank shaft.



ENGINE OF NEW SENTINEL STEAM WAGON

Another new feature in the engine is the placing of two cam shafts for operating the induction and exhaust valves inside the crank case. Formerly, one cam shaft only was employed, and it was placed underneath the cylinders. In this way the cam shafts are kept well lubricated by means of the splash from the oil sump. The cams are solid with the shaft. The valves, both inlet and exhaust, are arranged at one end of the cylinders. They are of stainless steel, actuated by long tappets, which can be adjusted for wear. The engine is provided with double glands between the cylinders and the crank case, obviating any chance of condensed steam finding its way into the latter. The feed pump is gear driven off the valve timing gear.



SECTIONS OF NEW SENTINEL ENGINE

The boiler has been altered so that the tubes, instead of being horizontal, are steeply inclined and arranged in three spiral groups. The inner cylindrical fire-box is pressed with a series of spiral grooves, into which the tubes are expanded. Besides having, it is claimed, better steam-producing qualities, this arrangement prevents pieces of coke, &c., lodging amongst the tubes and hindering the draught. Another advantage which the makers claim for it is that the tubes themselves form a natural shoot for the fuel, and there is now only necessary an upper half guide, which does not project beyond the centre of the tubes or into the fire-box. The boiler has a superheater.

The rear axle is a heavy round forging, and is now dead. On its ends it carries the two road wheels which run free on very long bearings. The wheels are bushed with phosphor bronze, and are secured by a simple locking device which allow them to be easily and quickly removed. On the inside of each wheel is a large brake drum, which contains the two sets of internal expanding brakes. The chain sprockets are secured on the outside of the drums. All the wheels are fitted with solid rubber tires.

The makers have taken the precaution of testing the new features very thoroughly before placing them on the market. As a matter of fact, engines of similar design have been in use in the company's power-house for two years night and day at a speed of 360 revolutions per minute, and generating about 60 horse-power. They are driving air compressors.

All the parts of the wagon are built to jig, the machining being carried out on specially designed tools. The wagons are tested thoroughly before being placed on the road. For this purpose a testing plant is used. It consists of two pairs of wheels mounted in pits and adjustable as regards their centres. The wheels are geared together and have wooden rims. The rear wheels of the wagon make contact with one pair of wheels and the front wheels with the other pair. The wheels drive by means of chains an electric generator in the pit, and the output from this generator is absorbed in resistances outside the shop. To put a load of from 4 to 10 tons on the wagon, a pneumatic ram is employed. The power of the engine and the equivalent road speed are given on an ammeter, voltmeter and tachometer.

The New French Navy.

THE first part of the French naval programme, which covers the period until 1925, provides for the construction of three light cruisers, the transformation of the battleship Béarn into a seaplane carrier, six destroyers, twelve torpedo boats, six first-class and six second-class submarines. The cruisers of 8000 tons displacement, known as the Duguay-Trouin, La-Motte-Picquet and Primauguet, will be 175.30 m. long, 17.20 m. in beam, and will draw 5.30 m. of water. Eight small-tube generators fired with oil will supply steam to Parsons geared turbines, driving four shafts and developing a total of 100,000 horse-power. The speed is to be 34 knots. The armament will consist of eight 155 mm. guns in eight double turrets, four anti-craft guns, and four 550 mm. torpedo tubes. These cruisers will have no protection and everything is to be sacrificed to speed. The Béarn is one of the battleships under construction at the time of the outbreak of hostilities, and while the three uncompleted sister ships have been scrapped, she was too far advanced to share the same fate, and is to be converted into a seaplane carrier by the Forges et Chantiers de la Méditerranée. She has a length of 175 m., a beam of 27.16 m. and a draught of 7.86 m., and is driven by two turbines and two reciprocating engines developing 35,000 horse-power. The twelve steam generators are fired with oil. The armament will consist of eight 155 mm. guns, six anti-aircraft guns and six torpedo tubes.

Following the practice in the British Navy, the light craft are designated by names representing a class, the six destroyers being known as the Jaguar, Panthère, Léopard, Lynx, Chacal and Tigre. Having a displacement of 2400 tons, their length is 119.70 m., and their width 11.08 m. They will have two geared turbines of the Rateau or Breguet type developing 50,000 horse-power. Steam will be supplied by five oil-fired generators. The speed is expected to be 35.5 knots. They will be armed with six 130 m.m. guns, two anti-aircraft guns and two triple torpedo tubes. The twelve torpedo boats will have meteorological names, such as Orage, Tempête, Tornade, and will have a length of 99.30 m., and a beam of 9.64 m., and be fitted with two geared turbines developing 30,000 horse-power. Steam will be raised in three generators with oil fuel. The speed will be 33 knots. The torpedo boats will have four 130 mm. guns, one anti-aircraft gun and

two triple torpedo tubes. The six first-class submarines are to be named the Ilequin, Souffleur, Morse, Narval, Marsouin and Dauphin. Their displacement at the surface will be 1147 tons, and submerged 1438 tons. Their length is to be 78.25 m., and beam 6.84 m. For navigating at the surface they are to carry two Diesel engines developing 2900 horse-power, and for under-water propulsion two electric motors of 1800 horse-power with a battery of 248 accumulators. The speed at the surface is to be 16 knots, and submerged 10 knots. Each submarine will carry a 10 cm. gun and ten torpedoes in tubes and six in reserve. The six second-class submarines, named Ondine, Ariadne, Naïade, Sirène, Circé, Calypso, will be practically of the same type but smaller. Their surface speed is to be 14 knots, and under water speed 9.5 knots. The displacement at the surface will be about 600 tons, and submerged from 750 to 775 tons. In the four submarines constructed by the Chantiers de la Loire and Schneider, the two Diesel engines of 1200 to 1300 horse-power will be of the two-cycle type, but the vessels built by the Chantiers Normand will have four-cycle engines. The electric motors will be of 1000 horse-power. The length of the second-class submarines will vary from 62 m. to 66 m., and the width from 4.94 m. to 5.40 m. The vessels are being constructed to the builders' plans prepared according to specification. These submarines will carry one 10 cm. gun and eight torpedoes.

The credits voted for this part of the programme amount to 775 million francs. It is estimated that the light cruisers will cost 80 million francs each, the destroyers 28 millions, the torpedo boats 18 millions, the first-class submarines 17 millions, and the second-class submarines 10 millions. The work of construction is already well in hand, the cruisers in the arsenals, and most of the light craft in private shipyards, and it is expected that the whole will be completed early in 1925.

Electric Control Gear.

Some interesting electrical control gear is being manufactured by Electric Control Gear, Limited, of Hastings House, Norfolk-street, Strand, to the order of the Great Western Railway Company. The gear is to be used at the Cardiff Docks in connection with the Great Western Railway Company's pumping installation. As will be seen from the accompanying diagram, there are four main pump motors to be controlled and two auxiliary pump motors. The current for the main motors is supplied to the stator windings directly from the bus-bars and without the use of transformers. Each of the high-tension automatic controllers consists of two triple-pole air brake high-tension contactors with a charging resistance and a time element device. The controller for the rotor circuit consists of a number of double-pole rotor contactors with the necessary rotor resistance, and automatic adjustable time element for governing their control, and an additional double-pole rotor contactor with a special buffer resistance of high ohmic value, which is connected across the star point of the rotor.

Normally the operation of the gear will be as follows:—Assuming No. 1 accumulator drops sufficiently for the tappet connected to it to operate No. 1 tappet switch, the first high-tension stator connector is then closed, and the stator circuit of the motor is closed through the charging resistance. After a predetermined interval, the second high-tension triple-pole contactor closes, thus short-circuiting the charging resistance in the stator circuit when the full bus-bar pressure is supplied to the stator of the motor. Next, the special double-pole rotor contactor closes, thereby short circuiting the buffer resistance in the rotor circuit, and afterwards the various rotor contactors close and cut out the rotor resistance in the correct order until the motor is running at full speed. When stopping the reverse action takes place. All the rotor resistance is first inserted, then the charging resistance in the stator circuit, and finally the stator circuit is opened, the system being designed to protect the motor and to prevent high potential differences between the windings. The second tappet switch to be seen on No. 1 accumulator starts the second motor.

The object of the selector switch, to be seen on the right of the diagram, is to enable the sequence of the starting to be varied so as to equalise the load on the various pumps. For instance, in one position of the starting switch the order of the starting would be 1, 2, 3 and 4, and in the other position 2, 3, 4 and 1, and so on. The auxiliary pump motors, it will be noticed, are supplied through a step-down transformer, so that the stator windings of these motors are supplied with low-tension current, and this transformer also serves for supplying the control circuits of the high-tension controllers and also the current for lighting purposes.

The whole of the apparatus is completely interlocked so as to give perfectly safe operation under all conditions, and devices such as pressure gauges, alarm bells, &c., are provided for the protection of the hydraulic end of the plant. In addition to the automatic gear there is a complete system of hand-operated isolating switches with automatic overload trip and no voltage release gear.

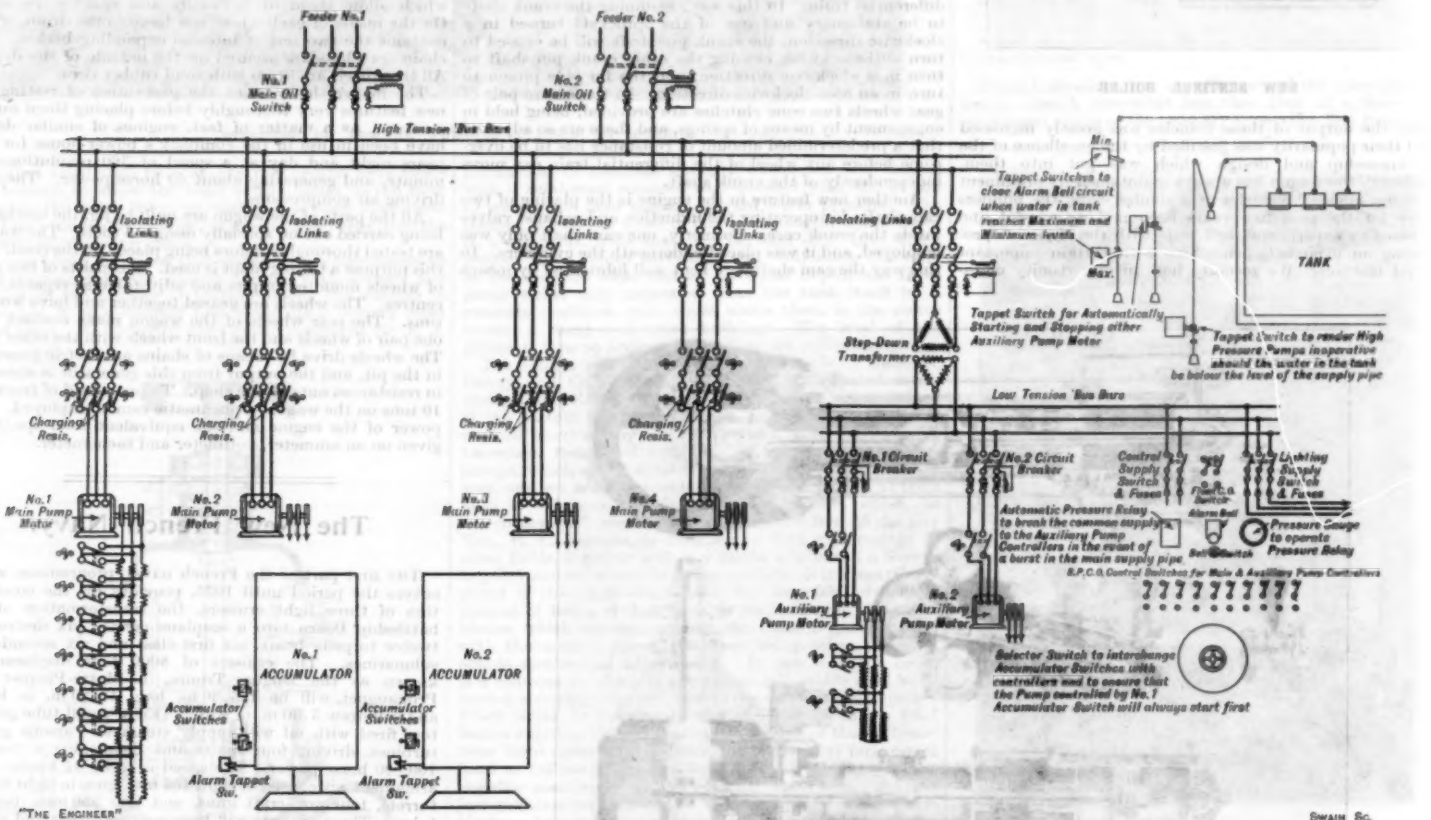

Feeder No.1
Feeder No.2
No.1 Main Oil Switch
No.2 Main Oil Switch
High Tension Bus Bars
Isolating Links
Charging Resis.
No.1 Main Pump Motor
No.2 Main Pump Motor
No.3 Main Pump Motor
No.4 Main Pump Motor
No.1 ACCUMULATOR
No.2 ACCUMULATOR
Accumulator Switches
Alarm Tappet Sw.
Step-Down Transformer
Low Tension Bus Bars
No.1 Circuit Breaker
No.2 Circuit Breaker
Control Supply Switch & Fuses
Lighting Supply Switch & Fuses
Alarm Bell
Bell Switch
Pressure Gauge to operate Pressure Relay
No.1 Auxiliary Pump Motor
No.2 Auxiliary Pump Motor
Min.
Max.
TANK
Tappet Switches to close Alarm Bell circuit when water in tank reaches Maximum and Minimum levels
Tappet Switch for Automatically Starting and Stopping other Auxiliary Pump Motor
Tappet Switch to render High Pressure Pumps inoperative should the water in the tank be below the level of the supply pipe
Automatic Pressure Relay to break the common supply to the Auxiliary Pump Controllers in the event of a burst in the main supply pipe
S.P.C.O. Control Switches for Main & Auxiliary Pump Controllers
Selector Switch to interchange Accumulator Switches with controllers and to ensure that the Pump controlled by No.1 Accumulator Switch will always start first
"THE ENGINEER"
SWAIN Sc.

DIAGRAM OF ELECTRIC CONNECTIONS FOR PUMPING STATION AT CARDIFF DOCKS

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

MECHANICAL GEARING.

Sir,—The many failures of double-reduction gearing on marine turbine installations have, as we all know, taken alarming proportions lately, and many shipowners have seriously considered reverting to the reciprocating type of steam engine or adopting the internal combustion engine. Now, all sorts of possible causes have been investigated by eminent engineers and scientists, such as torsional vibration, the heat treatment of materials, the want of alignment, &c., and various ingenious remedies have been suggested, but it remains a fact that we are no nearer the solution of this all-important question.

It has always seemd to me that any slight deficiency in the balance of gear wheels, which would be most noticeable in the intermediate wheels, being of a comparatively large mass and revolving at a relatively high speed, is bound to make itself felt some way or other, either by tangible vibration or objectionable noise in or around these wheels, and, of course, this means undue wear of the weakest link in the transmission chain—in this case, the teeth.

I have had some experience with the balancing of marine turbine rotors, &c., and invariably found that by obtaining their balance as accurately as at all possible—that is, within grammes on their circumference per ton of their weight—which can be easily done by present methods, their running was so much improved in comparison with rotors not so balanced, that experienced marine engineers remarked on their vibrationless, quiet running, when seeing them in service. Moreover, their bearing wear was negligible after perhaps 200,000 miles of active service.

I visited one of the largest continental machine tool works some time back. The owners attach very great importance to the accurate balancing of all their tools' rotating parts. All shafts and lay shafts, with their pinions, gears, clutches, &c., are carefully balanced before being fitted to the lathe, drill, planer or other tool, as the case may be. They have found such benefit from this course that they would never think of dispensing with balancing any more. The vibrations and noise in the transmission, which they had always ascribed to the more or less imperfect shape of the machine-cut gear teeth, had entirely disappeared, which proved that not the actual perfecting of the tooth shape, but the collective unbalance of the various transmission parts had more to do with it than they had previously imagined.

As a result, the lathe required appreciably less power to drive it and ran more steadily, the wear of bearings, &c., is bound to be less, and an all-round gain is obtained in the lathe's output, life and quality of the work produced by it. Electric-driven lathes so balanced can have their motor superimposed on the headstock, providing the motor is similarly balanced, thus saving ground space.

Now, I think from these facts it would not seem unlikely to expect that if we balanced all the parts of marine reduction gears in a similar accurate manner that better results might be obtained in their operation. In these larger gears I realise greater care is taken to get a more perfect tooth shape than in the average tool transmission gears, but notwithstanding these expensive precautions, failures keep on occurring, which does not look as if it will solve matters. As Sir George Goodwin lately remarked when discussing the paper on "Mechanical Gearing," by Sir Charles Parsons and others, before the Naval Architects: "Let us hope the solution of the difficulties does not rest with greater accuracy of gearing being required, which would be difficult and expensive to maintain under service conditions."

It is, of course, possible the trouble may be due to outside influences transmitted from the turbine or propeller or from flexibility of the foundations to the gears, but several investigations, supposing it to originate from such external sources, have not proved anything definite so far. Mr. MacAlpine's floating frame will most certainly protect the gears against alignment trouble, but not from inaccuracies which exist in the metals of the wheels themselves.

In view of this, I suggest it may be quite likely that the trouble may have been as often due to want of balance, thus an internal fault in the gearing, which we can nowadays easily correct, as to any other not yet detected cause. The external forces on lathes and marine gears are very different, I grant; but it is none the less quite conceivable that a careful investigation, as suggested, may lead to some very encouraging results, and if not entirely solve the trouble, anyway help to bring us nearer the root of evil. We start hunting, as it were, for the trouble from the inside of the gears themselves, as opposed to most of the searches, which have begun from external sources, and all of which seem to have either missed or not reached the source of trouble. Messrs. Parsons, I am glad to see, have now been experimenting on the heat treatment, which is also inside the wheels. I do not think we need to hunt for the trouble outside the gears any longer.

W. Hamilton Martin.

London, March 27th.

UTILISATION OF EXHAUST STEAM IN LOCOMOTIVES.

Sir,—My attention has been called to the article in your issue of March 16th, in which the writer suggests, on the authority of D. K. Clark, that the first use of waste steam for feed heating by turning such steam into a cistern attached to the smoke-box (*sic*) was by Hackworth, on the Royal George, in 1827.

This arrangement had, however, been previously, though not necessarily for the first time, adopted by Robert Stephenson and Co., on an engine which was in existence some time before the Royal George was built. A contemporary account of this engine is extant.

I may add that a search extending over the past two years has brought to light much information on the locomotives of

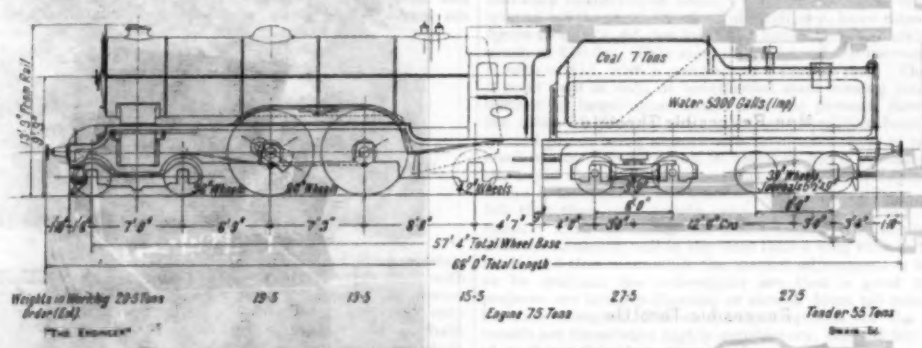
the period, 1825–1828, which involves a revision of some statements which have been made about particular engines. This information, hitherto ignored by writers on the locomotive, will shortly be published, with full references to the sources from which it has been obtained.

Darlington, March 27th. J. G. H. WARREN.

DESIGN FOR AN EXPRESS LOCOMOTIVE.

SIR,—As one who takes a great interest in locomotive design and performance and who has had opportunity from time to time of noting the working of modern locomotives on our railways, I venture to send you for your consideration and criticism a design which I have worked out for an engine for conducting high-speed heavy passenger services.

I apologise—if, in your view, it is necessary—for not offering something more novel, complicated and costly than a straightforward ten-wheeler, having the "Atlantic" type of wheel arrangement. I may be taken to task for proposing a four-coupled engine, but I will run that risk. There may be, and probably are, occasions on which a six-coupled passenger engine is necessary, but, judging by the truly wonderful work which the four-coupled locomotives on the Great Northern and North-Eastern sections of the London and North-Eastern Railway perform, I feel bound to think that success must follow the introduction of a similar type increased in the necessary dimensions to provide the requisite power to meet modern conditions.



MR. POULTNEY'S DESIGN FOR AN EXPRESS LOCOMOTIVE AND TENDER

The drawings show an engine which may be said to be a development of the classes named. In it I have incorporated all those details which I personally favour. Three cylinders are proposed, and in this I do not anticipate any adverse criticism, the advantages of three cranks at 120 deg. being too strong to be passed over. The equal turning moment and the favourable disposition of the balance weights are specially advantageous for a four-coupled locomotive.

The cylinders are separate castings; those outside are duplicates and interchangeable; the centre cylinder is cast complete with the saddle, which also has exhaust ports cored in it, registering with those from the outside cylinders.

It is possible that exception may be taken to the drive being made through one axle. To have divided and connected the outside motion to the trailing coupled axle would have necessitated long and heavy rods. The advantages of the arrangement shown are duplicated and light motion parts. The connecting-rods are alike, except for the big ends. The centres are 78in., which with a 24in. stroke gives a length of 3¼ strokes. I propose the solid bush form of end for the outside connecting-rods, whilst for the inside rod, the big end would be of the open-ended type, with the brasses held by cotters.

The slides are of the three-bar type, which permits of the use of light-weight cross heads.

In the matter of valve motion, I make no apology for introducing the old and well-tried Stephenson gear. Some of the best work in this country has been, and still is, accomplished by engines so fitted. The valves have inside admission, and as rockers are used, the rods are open. Steam reverse gear is shown. It is handy and saves a long reach rod, difficult to arrange with a wide fire-box.

The boiler is of fairly ample size, and proportioned to produce steam economically, so far as my knowledge permits. The fire-box capacity is considerable, and the tubes are of medium length, and of moderate diameter, in order that the hot gases may be divided into a number of thin streams. Arch tubes are provided in conjunction with very ample water spaces round the fire-box, which is of the wide type, having a round topped casing.

The superheater has the type A, or McKie, header, having through bolts and spherical element connections.

The boiler is carried on a cast saddle, to which the smoke-box is bolted, and the fire-box is supported on expansion shoes, one at each front corner carried on a cross stretcher, and at the hind end by a vertical plate. The framing and wheels call for little comment. To secure easy riding, long laminated springs are used, those for the coupled axles being connected by equalisers. The bogie wheel base is 7ft., as against 6ft. or 6ft. 6in. The Adams bogie is shown, and the trailing axle has radial boxes. The main frames are 1⅛in. thick, and are double under the fire-box. They are suitably braced by cross stretchers, that between the coupled axles carrying the brake cylinders. Steam sanders, arranged to work together or separately, are provided for the leading and trailing coupled wheels.

There is little to say about the tender, except that the tank is formed in a similar manner to the Tollerton tenders on the Rock Island, having the sides and bottoms connected by flanged plates, thus avoiding angles. The sides at the top of the bunker are curved inwards slightly, to avoid loss of fuel. The tank is carried on an underframing of rolled sections, and two four-wheeled trucks are used, having outside frames and axle boxes, equalised spring gear, and clasp brakes. A water scoop would be provided if required.

The chief dimensions are shown on the drawings, and the proportions are given in the tabulated statement.

On the matter of weights, those given are what I think the locomotive would scale. They have been arrived at after comparing with existing "Atlantics" weighing as follows:—

	Tons.
G.N.R., Ivatt and Gresley	68.3
N.B.R., Chalmers	76.7
N.E.R., two-cylinder	74.7
N.E.R., three-cylinder	77.1
Proposed, three-cylinder	75.0

The engine under notice is much like the G.N. engines in general, but the three cylinders and larger boiler, with slightly greater length overall, adds, I judge, about 7 tons to the weight.

The engine is designed to handle 500–600-ton trains at 60 miles per hour, and to maintain at that speed 1600 indicated horse-power, and the data given indicate, I think, that the specified duty should be performed without any difficulty.

It will be noticed that the boiler power is 96 per cent. according to Cole, estimated on a steam rate of 20.8 lb., but as the engine would develop the power specified at a 25 per cent. cut-off, the steam consumption would probably be not more than 17 lb. to 18 lb. per indicated horse-power-hour.

(General Data Estimated.)

Rated tractive force, mean pressure 85 per cent. of boiler pressure	22,410 lb.
Cylinder H.P. (Cole)	1,573 lb.
Boiler H.P. (Cole)	1,518 lb.
Speed at 1000ft. piston speed	50.4 m.p.h.
Steam required per hour	32,718 lb.
Boiler evaporative capacity per hour	31,581 lb.
Coal required per hour, total	5,112 lb.
Coal rate per square foot of grate per hour	136 lb.

Weight Proportions.

Weight on drivers / Total weight, engine	52 per cent.
Weight on drivers / Rated tractive force	3.9
Engine weight / Cyl. H.P.	105.5 lb.
Engine weight / Boiler H.P.	110.6 lb.
Engine weight / Combined heating surface	37.2 lb.

Boiler Proportions.

Boiler H.P. / Cyl. H.P. per cent.	= 96.2
Combined heating surface / Cyl. H.P.	= 1.86
Equivalent heating surface / Cyl. H.P.	= 2.06
Tractive force / Combined heating surface	= 7.65
Tractive force × dia. of drivers / Combined heating surface	= 611
Cylinder H.P. / Grate area	= 42
Fire-box heating surface / Grate area	= 4.7
Combined heating surface / Grate area	= 78.3
Fire-box heating surface, per cent. of total	= 6.05
Superheat surface, per cent. of total	= 21.0
Tube length / Inside diameter	= 110.5

I have addressed you at considerable length, and fear that I may have placed somewhat heavy demands on the space of your correspondence columns. Knowing, however, the sympathetic manner in which you look upon steam locomotive matters, I do not hesitate to offer my design for your consideration, and also for such comment as those interested of your readers may care to offer.

I suppose most engineers who follow locomotive performances and construction have their own ideas of the form that an engine for a given service should take, and the drawings I have made form my own considered opinion on this subject.

The particulars not shown on the drawings are as follows:—

Heating Surfaces.

	Square feet.
Water contact—	
Tubes	1507.5
Flues	635.4
Fire contact—	
Fire-box	162.0
Arch tubes	16.0
Superheater elements	616.0
Total evaporative	2320.9
Total combined	2936.9
Equivalent	3244.9
Grate area	37.5

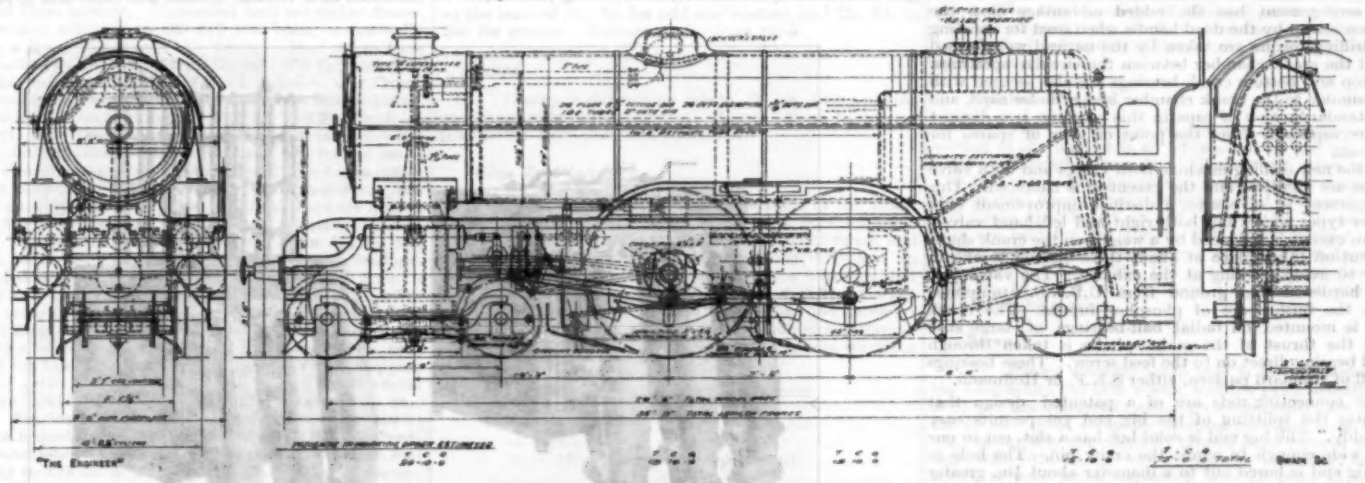
Three cylinders, 18in. diameter, 24in. stroke, 8in. piston valves

Stephenson's valve motion, three sets

Full gear cut-off, 65 per cent.

E. CECIL POULTNEY.

Llandudno, April 6th.



MR. POULTNEY'S DESIGN FOR AN EXPRESS ENGINE

HARDNESS TESTS.

SIR,—Your article dealing with the Herbert pendulum tester was interesting, but there is one point arising therefrom on which perhaps you or your readers can give further information.

It was stated that "three specimens of high-speed steel, supposed to be hardened alike," were tested, but the hardness figures varied. We have had very considerable experience in comparative testing of hardened articles, and it is a puzzle to us why two articles hardened at one and the same time from the same pieces of steel, and in spite of the greatest care to make the conditions absolutely identical, prove variable in actual durability when tested to destruction on work. Time and again, two articles put in the muffle side by side with a view to making the heat conditions identical and inserted in the oil side by side so as to make the quenching conditions identical and tempered together, have given absolutely different results.

The steel makers claim their steel to be uniform, but as analyses are expensive, we have only analysed now and again, and the results have shown the analysis to be within the commercial limits. It seems impossible to get steel in which the carbon can be guaranteed not to vary up or down by more than .02, but even two pieces of steel taken from the one piece of steel will show variations.

If any information can be given as to the reason for these great variations in hardness, we should be very glad to learn of it.

April 16th. MANUFAC.

Pneumatic Drilling Machines.

A form of pneumatic drilling machine, which, although it follows orthodox principles in the design of its leading features, embodies several distinct improvements, is shown in the accompanying drawings. It is being made by the Globe Pneumatic Engineering Company, Limited, of 1, Victoria-street, Westminster, and is of the well-known four-cylinder V type, with Corliss valves. The cylinders are about 1¼in. in diameter by 1in. stroke.

The divided crank chamber, introduced in 1908, has now been abandoned on account of the extreme difficulty in maintaining oil-tight joints simultaneously in a lateral and longitudinal direction, as well as proper crank shaft alignment. The new design has only two casings, the upper containing the engine and the lower the gears and Morse taper spindle. Instead of following the usual practice of casting large rectangular apertures on either side of the crank chamber circular openings are formed in direct line with each cylinder, so that each cylinder is virtually continuous with a cap on each end. This construction has the advantages that the crank apertures are greatest where needed—that is to say, directly opposite each crank pin. They are also closed by caps identical with the cylinder heads, and may readily be removed or assembled without it being necessary to break a joint and remove a number of troublesome screws and washers. The arrangement has the added advantage that the stresses set up by the dead handle when used for resisting the drilling torque are taken by the natural web formed round the crank chamber between the circular apertures. The top and bottom crank bearings are also secured with caps similar to the crank chamber and cylinder caps, and the standardisation of caps in this machine is a distinct feature, especially from the point of view of spares for renewals.

In the new drilling machine both valves and both valve bushes are identical and the excentric is balanced. This arrangement is, of course, a distinct improvement over former types which had both right and left-hand valves, and an excentric balanced by a weight on the crank shaft. The cut-off takes place at about three-quarter stroke in order to avoid freezing at the exhaust. The valves are case hardened and ground from U.B.A.S. stampings, while the bushes are of phosphor bronze. The crank shaft is mounted on radial ball-bearings of large size, while the thrust of the main spindle is taken through a ball bearing direct on to the feed screw. These bearings are all of standard pattern, either S.K.F. or Hoffmann.

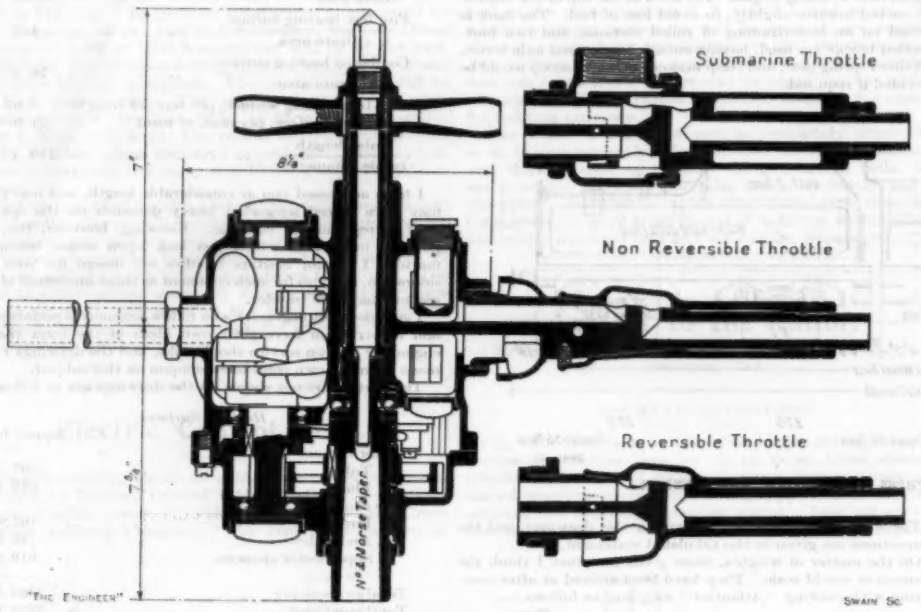
The connecting-rods are of a patented design that obviates the splitting of the big end yet permits easy assembly. The big end is solid but has a slot, cut in one side, wide enough to admit the crank pin. The hole in the big end is bored out to a diameter about ¼in. greater than that of the pin, and a split bush is used to make up the difference. Two connecting-rods work on each crank pin, and in assembling them they are hooked over the pin, through the slot just mentioned. One half of the bush, which serves for both rods, is then slipped into place between the bore of the big end and the pin, the end of the central crank web being radiused off to permit this being done. The half bush is then turned half round the crank pin, and the second half slipped in place. The big ends cannot come off the pin as the bush is too big to come through the slot, while the two halves of the bush are held in place by a little spring slipped into a central groove. The makers inform us that they have never known any one of these big ends to fail through breakage. Their simplicity and convenience needs no comment. The four pistons, connecting-rods and crossheads are all interchangeable and are each made in two pieces, the ball socket for the connecting-rod being integral with the piston and the connecting-rod integral with the big end, being stamped in one piece.

Another patented feature of the machine under review is the provision for an efficient vent hole. Trouble caused by the leakage of air and consequently the blowing out of the lubricant has been considerable in all pneumatic drills. The lubricant is usually poured into the drilling machine only to be blown out through the vent immediately the air is turned on, with the result that the vent is often plugged by the operator and the trouble accumulates, and is not discovered until the machine fails. It is estimated that a considerable number of mishaps, such as fracture of the running mechanism and the stalling of the drill are caused by back pressure which accumulates in the casing through the small leaks past the piston and valves. Machines that have failed owing to the fracture of the connecting-rods have been carefully examined and it has been found that the damage has been caused because the vent has been plugged.

The vent in the new machine is formed in the throttle handle, which is so designed that when the air is turned on, the free chambers of the drill are in direct communication with a free exhaust, and when the throttle is closed the vent system is also closed. Thus, there is no escape of oil through the vent when the drill is lying idle. Air is admitted through the usual grip handle, which in this machine is of the taper plug design with means of adjustment for wear. The whole of the exhaust takes place at the junction of the throttle and the drill casing. Reversing is effected by reversing the direction of the air flow, so that the exhaust becomes the inlet and *vice versâ*. A non-reversible machine can be converted into a machine suitable for tapping, &c., by simply changing the throttle handle.

There are, it is claimed, fewer different parts in the new "G.P.E." drilling machine than in those of any similar 4-cylinder design, and the need for numerous spares is rendered unnecessary. All machines are thoroughly tested for power output, either by a drilling test or on the test-room dynamometer, before being transferred to store, and are given a further run prior to leaving the works. The air consumption of each drill is measured upon a "Kent" air meter. Although drilling tests are quite effective for high-speed machines, the brake test is found to be much more reliable for the compound geared types used for heavy reaming, tapping, and flue rolling. The new drilling machines are from 3 lb. to 8 lb. lighter in weight than the former pattern, and overall dimensions have been slightly reduced.

During our visit to the works where these drilling machines are manufactured, we tested one with a brake, and found that it had an output of 1.6 horse-power when supplied with air at 95 lb. per square inch, and running at 60 revolutions per minute. It was also noteworthy that it would start from rest against the full torque represented by that load. With another machine we drilled several 1¼in. holes through a mild steel plate 1in. thick, and found the average time to be just under one minute. The makers told us, in fact, that they will not pass out a drill unless it "will beat a minute."



THE GLOBE PNEUMATIC DRILLING MACHINE

Outdoor Switchgear.

Some interesting switchgear which has been designed for outdoor service, has recently been brought to our notice by Schuil and Gullinan, of Target Hall, Hebburn-on-Tyne. The gear was developed during the war to meet the demand for current in various continental districts, and especially in Holland and Belgium. By means of these open-air switches, it is possible to connect up small factories using, say, 5 or 10 kilovolt-ampères, or groups of, say, ten houses. The switches may be placed at the roadside adjacent to a transformer or the transformer may be fixed in a nearby house. The switches may, of course, also be placed in a cellar of a building, or in any other convenient position. The isolating switches are guaranteed to break the circuit under a load of 200 ampères at a pressure of 10,000 or 12,000 volts, whereas automatic switches will break as much as 120,000 kilovolt-ampères.

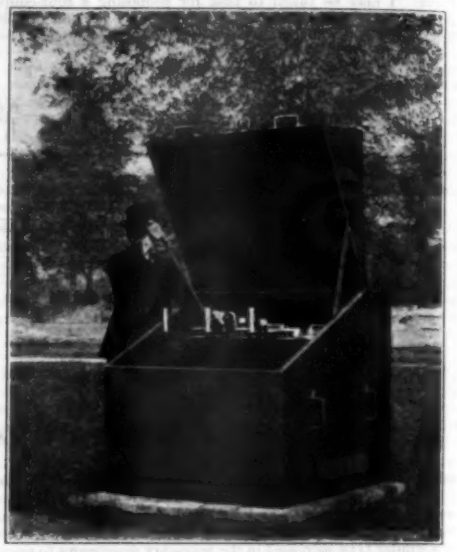
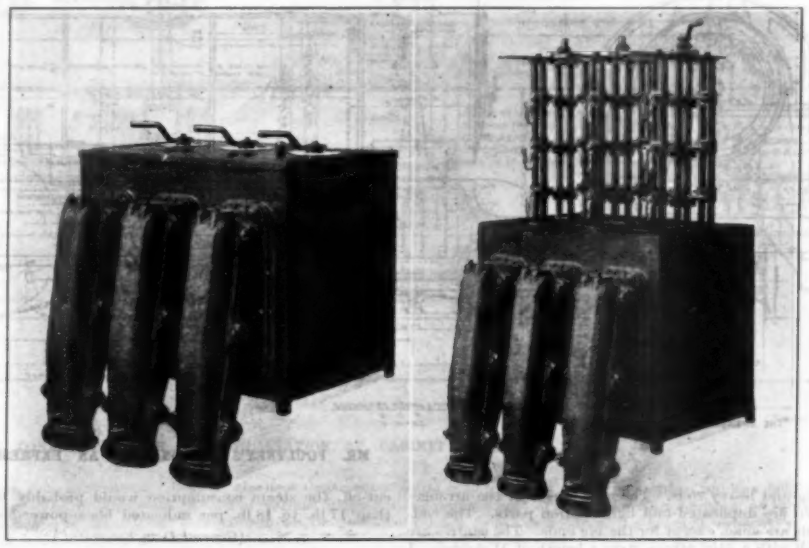


FIG. 1—SWITCHBOX IN CASE WITH HINGED LID

All the switches in use in Holland are designed for a pressure of 10,000 volts and a current of 200 ampères, but they are also capable of interrupting a circuit carrying 200 ampères at a pressure of 12,000 volts. Switches designed for a pressure of 24,000 volts are also made.

The switch-box—as shown in Fig. 2—contains all the switching equipment and three bus-bars which are mounted on insulators at the back of the box. There are three quick break three-phase switches, which are mounted on a vertical spindle, and three sets of contacts connected to the incoming cables, and all the gear can be lifted out of the box—as shown in Fig. 3.



FIGS. 2 AND 3—SWITCHBOX FOR OUT-DOOR USE

This form of construction, the makers state, enables the gear to be supplied at low cost, without detriment to workmanship or the use of inferior materials. The non-automatic switches are of the quick make and break type, and some of the switches are provided with hinged covers—as shown in Fig. 1—whilst others are placed inside kiosks, which may be fitted with telephones and cable boards for testing purposes. To meet the Board of Trade requirements in this country, the makers have introduced certain modifications and improvements. The outgoing mains, for example, have been provided with short circuiting earthing devices with interlocking gear, so that the earthing switch can only be closed when the corresponding main switch is open. For voltages of 3300, 6600, 12,000 and 24,000 volts, the standard working current is 200 ampères; but for pressures below 3300 the switches are made for heavier currents.

From one to five switches can be fitted in the same

box, according to requirements. A three-unit isolating switch, with one or two automatic switches, can be made to serve as a complete sub-station at a cost of about one-fifth of that of a sub-station of the ordinary kind. Potential and current transformers can be fitted to the gear so as to enable voltage and current measurements to be made. For mining and general underground mining work spiral gear of this type is supplied, and also for 20,000-volt overhead transmission work.

Switches—such as that shown in Fig. 2—have three sealing chambers, each of which serves for the reception of a three-core cable, one being the incoming cable, another the outgoing cable, and the third a branch cable, and either circuit may be controlled at will. The arrangement is claimed to be the cheapest that can be adopted for taking off a tee connection for a high-pressure system. Particular attention is directed by the makers to the fact that the phases are placed one above the other, with the result that space is saved, each set of three-phase switches being mounted on a light but strong framework, which can easily be withdrawn from the tank, and the whole of the gear is immersed in oil. Special attention has been paid to the oil-tight joint between the porcelain and oil and porcelain and copper conductors, and sealing boxes are filled with compound.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Ironmasters and the Budget.

MIDLAND engineers and iron and steel masters received the Chancellor's Budget proposals this week with expressions of gratitude for small mercies. They were much disappointed, however, to find that it was only proposed to reduce the corporation profits tax by one half. They would much like to see this tax altogether abolished, for they consider it unreasonable and unjustifiable. But even the reduction now in view, it is recognised, will have its prompt effect in facilitating the provision of capital for promising productive enterprise. The reduction of sixpence in the income tax following upon last year's reduction of 1s. will, it is considered, also tend to encourage fresh enterprise. Though it is agreed that these concessions will result in improved industrial activity, they leave a good deal to be desired.

Manufactured Iron.

Staffordshire ironmasters who specialise in the production of best class bar iron have found it necessary to follow their price advance of 10s. per ton, of a few weeks ago, with a further one of a similar amount, making to-day's price for Staffordshire marked bars £14 10s. In view of the increased cost of raw material and the appreciation of unmarked bars, this further step is quite intelligible. There are few signs of any great pressure of demand for bar iron. Makers of best bars have had a fairly steady outlet for their production, but notwithstanding the restraint that has been exercised in regard to prices, this branch is not exempt from the reactions which have attended the general unsettlement of business during the past three months. Unmarked bars are rather firmer, makers now adhering to the £12 10s. basis, occasionally getting a few shillings over this figure. Good orders have been booked by South Staffordshire bar mills in connection with the revival in the rolling stock industry, and Crown bar prices have risen steadily. Nut and bolt iron is dearer, Lancashire makers quoting £11 17s. 6d. and Staffordshire £11 12s. 6d. Demand for this material is somewhat spasmodic. Purchases of raw material are on the small side. Consumers cannot see far ahead, but to maintain current output they have to draw upon home supplies almost entirely, as the imports of Belgian bars are negligible. Antwerp shippers were recently quoting £9 15s. f.o.b. This would make the price here about £11 2s. 6d., only 7s. 6d. or 10s. below the figure at which South Staffordshire makers were prepared to do business. Such a margin would not tempt buyers at a time when the market is in a state of unstable balance, even if they could rely upon getting delivery. At present there are considerable quantities of continental material that have been contracted for but have not come to hand. While shippers speak of getting supplies through in two or three weeks, they are unable to give any definite assurance to this effect. Fencing iron, the demand for which continues to improve, is quoted by Lancashire makers at £12. Staffordshire ironmasters have increased the price of wrought iron gas strip to £13 5s. or £13 10s. This material now competes with steel strip at £12. The cheaper material is largely preferred, but the makers of iron gas strip state that iron is increasingly specified, in spite of the higher price, on account of the better resistance to corrosion.

Pig Iron.

Pig iron prices have apparently reached their limit, for there has been some pause latterly in the upward movement. But if supplies are any easier to obtain the improvement is hardly perceptible. Though the position is a little easier the foundries and other big users find it extremely difficult to obtain the raw material to fulfil engagements into which they have entered. Smelters also find the position difficult. It is a hard matter to keep the furnaces supplied with fuel. Coal has taken the place of coke in some cases, but notwithstanding all that could be done, furnaces have had to go on slack blast. Smelters' plants, which are operated in conjunction with collieries and coke ovens, have been able to augment their output, but those relying upon independent sources of supply have had to curtail theirs. The coke situation is, this week, reported to be somewhat easier owing to reduced exports. Coke makers have within the past week been able to increase their deliveries to the blast-furnaces. Most smelters are in arrears with their deliveries, and for the present are adhering to their quotations. As contracts expire they are being replaced by small scale purchases. Pig iron for prompt delivery is as difficult as ever to obtain. Most makers, indeed, are sold until the end of the quarter. Some furnace owners are willing to negotiate for July and August deliveries on the basis of prices now current, but consumers exercise great caution, for they hope that present difficulties will have been mitigated by that time. There is not much change in the price situation. In a few cases forge iron is stated to have been sold well above £5. Derbyshire foundry irons are quoted at £5 10s., and forge iron at £5 5s. Ferro-manganese has been advanced £1 to £18.

Steel.

Steel prices continue on the up grade, and as a result, wherever possible orders are being withheld, buyers having the impression that the present inflated condition of affairs will not continue. At the moment most mills want £10 10s. and upwards for angles, but in certain instances they are procurable at 5s. below this figure. All the joist makers are well booked. Some of them quote £10 15s., which is considered a signal that they do not want further business. Nevertheless there are one or two firms who still stick to the £10 5s. basis. Welsh firms, which recently quoted billets at £9 15s. for July delivery, have raised the figure to £9 17s. 6d. for August. Some firms are asking as much as £10 5s. Thin steel sheets have been increased to a basis of £11, with a prospect of a further rise. There is a good deal of talk of continental steel coming into the district in larger quantities. For the present, however, the offers of material are not on an attractive basis, the quoted prices being almost on a level with those of native steel works. Every week it becomes more evident that the rapid rise in steel values has arrested developments. There is no faith in the stability of present prices. It is felt that they may topple over as quickly as they have risen. But, assuming the correctness of the argument that the situation will in any case take a long time to right itself, and that meanwhile the market adjustment is likely to be gradual, the indications are that a good many projects are being postponed or slowed down till material becomes cheaper. The steel output returns for the past month are considered highly satisfactory, the 802,500 tons of steel ingots and castings produced being an increase of 95,400 tons on the previous month. The figures are the highest since September, 1920, and show a marked improvement on the average monthly output for 1922, which stood at 486,000 tons.

Galvanised Sheets.

Quotations for galvanised sheets show considerable diversity. Corrugated sheets of 24 w.g. can be obtained at £19 10s. and even slightly less, but many of the leading houses continue to ask £19 15s. The mills are well employed, most makers having good order books.

Tinned Sheets.

The Tinned Sheet Manufacturers' Association has advanced its prices by £2 per ton, making best charcoal £58; charcoal, £56; and unassorted grades, £52 per ton to 20 gauge. An advance of £1 per ton has been declared by makers of lead-coated sheets, the new basis being £28 per ton to 20 gauge.

Tinplates.

Tin-plates delivered Birmingham are now offered on the basis of 24s. 6d. for odd size wasters, and 25s. 6d. to 26s. for primes. Business is far from brisk.

Scrap.

Scrap is difficult to obtain, £5 10s. being named as the price for early delivery. Recent efforts to depress the market have not been successful.

Edge Tool Industry.

Manufacturers of heavy edge tools in the Black Country state that business is fairly good, both on home and foreign account. Makers report more confidence, and prices have been moving a little. In many directions up to the present prices have been cut to the extreme, and there has been a scramble for business, but the market has shown an upward tendency, and this has had a steadying effect on prices and induced a certain amount of buying from abroad. Practically all the foreign markets are doing business.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER, Thursday.

General Outlook.

THERE is an uncertain feeling in the markets this week which suggests that the top prices have been reached, at any rate in the iron and steel trades. The feeling in the non-ferrous metal trades is not quite the same, and it is not yet thought that copper and tin are necessarily at top prices. The doubt as to the security of values in iron and steel seems to have arisen at the Birmingham quarterly meeting, many members of the trade having come away from that meeting with rather a depressed feeling. It is true that "marked bars" were advanced on that occasion by 10s. per ton; but this was an overdue movement, and merely brings the price of this class of iron into relation with Scotch and Lancashire makers of bar iron. The demand all round seems to be slackening, but as the works are, in most cases, well provided with orders to go on with, and as costs of manufacture are not reduced, the effect of the slackness on prices was not felt.

Metals.

The markets for non-ferrous metals have no been very active, but so far as copper is concerned, the prices do not depend very much upon trade conditions here, but rather on trade conditions in America. As a matter of fact, there has been rather more buying recently in Great Britain and in Europe generally. The Exchanges in France and Germany have been a little more favourable, and any further increase in the value of the franc may bring in more orders. On the other hand, consumers of copper in America are holding off the market; but this may be, not because there is a lessening consumption there, but because users of copper are now well supplied and must wait a little before they begin to buy again. The official prices for manufactured copper and brass are now as follows:—Copper sheets and rods, £106 per ton; flat bottoms, £116 per ton; copper 4ft. by 4ft. sheets for India, £94 per ton; yellow metal 4ft. by 4ft. sheets, 8¼d. per pound; yellow metal rods, 7¼d. per pound; brass locomotive tubes, 1s. 1d. per pound; and condenser tubes, 1s. 2¼d.; copper locomotive tubes, 1s. 2¾d.; copper wire, 12 g., 11d. per pound; brass wire, 10 g., 11d. per pound. The market for non-ferrous scrap is still very dull, although dealers have been giving rather more of late. The result seems to be that dealers have now, in their warehouses, rather more old metal than they care to hold, and find some difficulty in liquidating it. Engineers do not seem to be buying scrap metal very freely, although prices are such as ought to tempt them. Good gun-metal scrap, for instance, can be bought at about £25 per ton below the present cost of making the same mixture from new metals; and there is a big economy in using old yellow brass. Old lead seems to be the only scrap metal which sells at its full value, as compared with pig lead. The market for tin has been quiet and rather weak of late, but the outlook is still very uncertain. The buying in the British tin-plate trade has been fairly good, and there has also been some improvement in general European buying. It is said that America has plenty of metal bought to last well into June; but this period is not now so far away, and it seems quite possible that American buying for shipment from the East will soon be resumed, in which case the market might strengthen again. The position in the lead market is now rather puzzling. The fall on this side has brought prices to a point where it is possible to consider export to America, provided, of course, that the American prices are maintained. Here, however, demand seems to be threatened by the building trade dispute. Lead has been about 45s. per ton cheaper than the highest point reached at the beginning of March. Spelter has been a quiet market, with a slight tendency towards greater ease.

Pig Iron.

The markets here for foundry iron are very quiet, and, of course, foundry pig is the main pig iron business in the Manchester market. There used, in years gone by, to be a very good business passing here in forge pig iron, but one hears very little of this now, and apparently most of it is done direct between ironmasters and iron manufacturers. The Manchester ironfounders are in no mood yet to pay the prices required by sellers. One does not quite see what they expect unless it be a sudden and complete putting right of the position in the German industry. Without this pig iron prices here are not likely to come down again. The Manchester price is now based on 110s. per ton at the Derbyshire furnaces, and all Midland pig iron is now quoted here at from 118s. to 120s. per ton delivered for No. 3. For Scotch No. 3 £7 per ton is still quoted. Hematite from the East Coast may perhaps be a little cheaper, but there is not much difference. The Scottish makers do not seem to trouble themselves now very much about this market; and, in fact, very few ironfounders here can afford to pay their price. The total tonnage of business passing here in pig iron is comparatively small, and so far as can be ascertained, the ironfounders of the district are mostly badly off for new work.

Finished Material.

The only change in prices in the manufactured section of the market is an advance of 5s. per ton in the price of Lancashire bar iron. The official price is now £12 15s. net. No change was announced in Lancashire iron or steel hoop prices. Sellers of steel joists and angles still quote £10 12s. 6d. to £10 15s. per ton. Round steel bars are held for £12 10s. to £13, which seems to show rather a large difference above angles. Flat bars and plates are £11 5s. to £11 10s. per ton. There does not seem to be much new business this week in the steel section of the market.

Scrap.

Heavy wrought scrap iron is in fair demand at the Lancashire bar iron works, and the price usually paid is £5 per ton delivered; although some dealers are trying for £5 5s. Steel scrap for melting purposes is at about 95s., as latterly the Sheffield buyers have refused to pay more than 102s. 6d. per ton delivered. Foundry, or cast scrap, is very much neglected, and all sorts of absurd prices are heard of. The fact is that the consumer does not want it, and, therefore, offers about half its value. One hears of founders offering only 70s. for good cast scrap. The real value of good broken machinery cast scrap in relation to foundry pig iron is about £5 15s. to £5 17s. 6d. per ton. Dealers, however, are very glad to get orders at £4 15s.

Rating of Machinery.

An instructive paper dealing with the Rating of Machinery was read before the Liverpool Engineering Society on Wednesday evening, by Mr. E. W. Pierce, a solicitor. In the paper the author traced the course of the legislation and judicial pronouncements which have led up to the establishment of the principle that certain loose machinery, whilst not liable to be rated *per se*, is liable to be taken into consideration in arriving at the rateable value of such premises as mills, factories, engineering works, and similar premises, as enhancing their value. This system was originated in the forty-third year of the reign of Queen Elizabeth. The author said the first serious attempt to deal with the matter was made in 1890, when a Bill to remedy the law as to the rating of machinery was framed, and the history of this Bill—and the succession of similar Rating of Machinery Bills, which were introduced into Parliament between 1890 and 1922—afforded a striking illustration of the difficulty of securing the passage through Parliament of

any non-Government measures, even where their object met with general approval. Speaking of the re-framed Bill, which was unsuccessfully introduced in 1921, and which failed to pass owing to the dissolution of Parliament, the author said he could not find any really forcible objections which had been advanced against it. On all sides it was admitted that in principle the amendment of the law provided by the Bill was one which was urgently called for in the interests of English and Welsh manufacturers.

Irrigation for Cotton Growing in the Sudan.

At a meeting of the Council of the British Cotton Growing Association, held in Manchester last week, Mr. W. H. Himbury, the general manager of the Association, submitted his report on his recent visits to India, Egypt and the Sudan. He referred to the difficulty of obtaining sufficient water for irrigation purposes in the Sudan. He said the dam which is being constructed at Makwar—and which it is expected will be completed in 1925—unfortunately will not give all the water required for the full Gezira scheme. It will only be sufficient to irrigate 100,000 acres. Mr. Himbury pointed out, however, that there is a possible solution by finding water elsewhere, and at no great capital expenditure.

Institution of British Foundrymen.

At a meeting of the Lancashire Branch of the above-mentioned Institution, held at the Manchester College of Technology a few days ago, Mr. Jos. Hogg, Burnley, was presented with a canteen of stainless cutlery as a token of appreciation of his services as honorary secretary of the branch since 1916. The president of the Institution, Mr. H. L. Reason, made the presentation.

Birkenhead Water Scheme.

At a meeting of the Birkenhead Town Council, held on the 11th inst., the chairman of the Water Committee, Mr. William Jackson, stated that when the Alwen scheme was originally drawn up, it was estimated that the cost would be £700,000. It is now estimated that the total cost will come out at £1,460,098. Instead of the estimated cost of 7d. per 1000 gallons, the actual cost, exclusive of distribution, will be 1s. 6d. per 1000 gallons.

Manchester's New Roads.

One of Manchester's new arterial roads, 2¼ miles long and extending from Slade-lane to Parr's Wood, was formally opened last week. It is a 100ft. roadway, divided into two 15ft. pavements, two 20ft. concrete carriageways, and a central portion, which may ultimately be used for tramways. Only one half of the roadway has been completed.

BARROW-IN-FURNESS, Thursday.

Hematite.

There is very little change in the hematite pig iron trade. With the restricted supply of coke, the furnaces are hardly meeting the requirements of customers, and certainly if more furnaces were in blast, there would be no difficulty in finding outlets for the iron. The home users are practically getting their requirements and are not over-keen to buy too far forward in some cases, for it is expected that there will be a slight easing in price later. This idea may prove quite wrong, but certainly orders for forward delivery in summer are offered at prices slightly reduced on those at present obtaining. It is difficult, as a matter of fact, to say how the market will go at present, and with the Continent as customers, the only worry of North-West makers is coke. Occasionally the supply gets so low as to interfere with full output from individual furnaces. The demand for special qualities of iron remains good, and the Midlands is a ready buyer of this speciality. There have been shipments of pig iron to Glasgow, Tréport and Bombay during the past week.

Iron Ore.

The iron ore trade remains the same, with the Cumberland pits experiencing chief share of the trade. There have been certain deliveries out of the district, including a part cargo to Tréport. There is not a great amount of foreign ore coming in, but what has been arriving has mostly come from Kirkenes. A fair amount is lying dumped at the Barrow Docks.

Steel.

The steel trade continues to be moderately employed. There is a little more work in Cumberland, and the Workington mills have orders, which have been held for some time, for approximately a two weeks' run. The Barrow mills are better circumstanced, and the rail mill still continues to be employed. The hoop and small bar mills are having a better trade. Foundries are a little better employed.

SHEFFIELD.

(From our own Correspondent.)

"Unsettled Industrial Weather."

THE speech of Mr. W. L. Hichens, chairman of Cammell Laird and Co., Limited, at the annual meeting last week, was hardly as cheerful as one would have liked to hear, and there are people who think that it took a less bright view of the situation than is really warranted. Mr. Hichens confirmed the general view that the immediate effect of the occupation of the Ruhr district by the French and Belgians has been to stimulate the iron and steel industries of this country, but added that he regarded this improvement as purely temporary, and believed that our industries—and indeed the whole world—would have been better off in the long run if the French had not embarked upon their great adventure. "The industrial weather," he continued, "is as unsettled as ever, and we are not justified in looking forward with any confidence to a long-continued improvement. Indeed, I am not sure that it is not misleading to talk of an improvement at all." People generally will at all events hope that this opinion will be refuted by the course which industry takes. The Master Cutler of Sheffield is one of those who are not inclined to be gloomy. He has preached optimism ever since his election, and in a speech only a few days ago he was as hopeful as ever of the future prosperity of the city.

Heavy Trades Still Busy.

Whatever the future may hold in store, it is the fact that the heavy trades at present continue to enjoy full activity. In Sheffield itself a few open-hearth furnaces can be found that are not in operation, but at Rotherham, Stocksbridge and Penistone working up to the maximum capacity is the rule. At the same time, it has to be admitted that the quantity of forward business on hand is not great, and if new orders are not booked at a faster rate than is the case at present, the activities will be in danger of slowing down. The high prices now prevailing are checking business, and the quantity of steel sold at the current rates is comparatively small. Prices are now inclined to ease somewhat. There is still an immediate market for all the pig iron that can be produced, and owners of blast-furnaces are showing their confidence in the position by putting more and more furnaces into blast. John Lysaght, Limited, last week lighted the No. 3 blast-furnace at its Normanby Park Steel Works. There are now five furnaces in blast at these works, which is a record for one individual plant in the Lincolnshire ironstone area. The works are employed at their full capacity, and are producing more iron and steel than at any previous time in the history of the firm.

The Lighter Trades.

The all-round improvement of Sheffield trade, which is so much desired, seems as far off as ever. It is only the mild steel, railway steel and other heavy sections that are really busy. The lighter side makes little or no progress. Even at the heavy iron and steel foundries there are many cases of great slackness, while makers of crucible steel, engineers' small tools, and files report that their position continues very unsatisfactory, especially so far as export is concerned. On the other hand, makers of tools and equipment for collieries are very favourably placed, and are enjoying the benefit of a very brisk demand for their products. There is a rather better call from the shipyards, but it is feared that this may be only temporary, as the current high prices for steel will cause shipowners to hold up orders for new tonnage. There is a great scarcity of ferro-manganese and ferro-silicon, which are largely used in the heavy iron and steel furnaces, and considerable rises in price are taking place.

Cutlery and Plate.

There is nothing much fresh to say about the old staple trades of Sheffield, which are in the main very badly situated. Reports from travellers as to their journeys to London and provincial centres are the reverse of encouraging. Shopkeepers are placing very few orders, as they complain of a marked decline of business over the counter. There is still a good demand for stainless knives and also for spoons and forks, but prices are severely cut. There is some improvement in German buying, and the demand for Sheffield scissors shows a recovery. German cutlery is still very plentiful and competes with the Sheffield article, but the disparity in prices is not so great as was the case up to recently. An interesting innovation in the sterling silver trade was brought forward last week at a meeting held in the city by the Faraday and other important societies for the purpose of discussing resistance to corrosion. Mr. Harold Turner, a silver manufacturer, announced that he had succeeded in producing an alloy of sterling silver which, while not acid-resisting, was resistant to ordinary atmospheric conditions, and maintained its brightness without polishing. Mr. Turner has been experimenting for the past two years, and has only within the last week or two arrived at a stage when he is able to issue the new alloy commercially to the trade. The alloy is known as Silanca, and its composition is at present a secret.

Shipbuilding Orders.

Although the chairman of Cammell's had little that was good to say of trade prospects, he was able to report that his firm had had a highly satisfactory year at its Birkenhead shipyard, and that there are thirteen ships under construction there at the present time. All this, of course, means a share of work for Sheffield. The heavy trades of the city also stand to benefit to some extent by an order for a new ship which has just been placed with Vickers Limited at its Barrow yard. This vessel is a self-trimming collier steamer for Messrs. Harris Brothers and Co., of Swansea. It will be 248ft. long, 38ft. 6in. broad, and 18ft. deep, with a deadweight of 2250 tons, and reciprocating engines of 900 indicated horse-power. This is the third ship of the same type to be ordered from the Barrow works within the last few weeks, the other two, which are of somewhat larger dimensions, being for Messrs. France, Fenwick and Co.

A Radio Relay Station.

Sheffield is shortly to possess improved facilities for the reception of messages by wireless telephony. The many wireless enthusiasts in the city have long been dissatisfied with the present state of things. There is no broadcasting station nearer than Manchester, and the distances from which the messages have to be picked up, coupled with the interference caused by ignorant or careless listeners-in, have made indulgence in the pastime, not only difficult, but expensive, as two, three or four valve sets have been necessary. Last week, however, Mr. P. P. Eckersley, the chief radio engineer of the British Broadcasting Company, was in Sheffield investigating the conditions, and so satisfied was he of the justness of the complaints that it is now proposed to establish a relay station in the neighbourhood of the city. It is expected that this station will be in operation in a month or so. By its means, the strength of signals received in Sheffield will be amplified several hundred times, and listeners-in will be able to obtain satisfactory results with the cheaper crystal sets of apparatus.

Mining Matters.

The way in which the collieries are striving to increase the amount of fuel available for the country has been shown several times recently by figures of larger outputs, and another record has now to be added to the list. Last week the Brodsworth Main Colliery, the oldest in the Doncaster district, set up a new world's record by drawing 30,020 tons, or nearly 1000 tons more than its previous best performance. There have been considerable developments at this pit since the war, and more are in progress. A new shaft, for drawing purposes only, is now being constructed, and when this is available, as it will be before long, output will be further facilitated. New miners' welfare schemes continue to be announced, and the popularity of baths is frequently shown. A sum of £9215 is to be available in connection with Earl Fitzwilliam's New Stubbin Colliery and Messrs. John Brown and Co.'s Aldwarke Main. Of this total, £8000 is to be allocated to Rawmarsh, and it is understood that this will, by arrangement with the Urban District Council, be devoted towards providing public baths for that area, while the remaining £1215, which goes to Greasborough, will be utilised in making additional slipper bath accommodation at the public hall which is to be erected there.

Gas v. Electricity.

An interesting statement as to the comparative economic value of gas and electricity has just been published by the Matlock Gas Company. It has been called forth by an application of the Notts. and Derbyshire Electric Power Company—which already has a permit to supply power in the district—for authority to supply current for lighting as well. The Matlock Gas Company states that for cooking, electricity at 6d. per unit would cost 10s. for 20 units, while one therm of gas at 10½d. would do the same work. For power, it claims, one therm of gas by gas engine is equal to 10 units of electricity. The price of gas per therm for power purposes is 9¼d., so that electricity at 3d. per unit would be three times as dear. For lighting, electricity may be supplied at 6d. per unit, but again it would be three times as dear as gas, which is 11d. per therm. While on this subject, I may mention that under the Notts., Derby and Leicestershire scheme, which has received the sanction of the Electricity Commissioners, electricity power stations to serve 10,000 square miles are to be erected at Nottingham and Derby. The scheme is to supply fourteen electrical districts, which were mapped out twelve months ago by the Commissioners, and the area embraces sixty towns and villages.

NORTH OF ENGLAND.

(From our own Correspondent.)

Cleveland Iron Trade.

THE position in the Cleveland pig iron trade has now assumed a much quieter appearance, but the falling off in the demand, which is regarded as a temporary phase, has had absolutely no influence upon prices, and unless coke prices fall—and of that there is no present indication—expectations of lower pig iron values seem to be out of the question. Makers are in a very strong position. They have sold nearly the whole of their prospective output to the end of June, and consequently they have no need to feel in any way disturbed over the smaller volume of inquiries now circulating. All the iron being produced is passing into immediate consumption, and probably long ere the existing contracts are completed, there will be a renewal of business on a bigger scale, as industrial requirements are steadily increasing. Already it is reported that continental buyers are in the market again for more iron, and even should a Ruhr settlement shut off some of the European markets as outlets for British iron, the home demand is sufficiently large to absorb the output of the blast-furnaces now operating. Efforts to increase output by restarting more furnaces are still baulked by the coke scarcity, and although there is a distinct easing of the continental demand for coke, the disparity between export and home prices is still too great for the home trade to receive any preference. Thus supplies of coke to the furnaces are as dear and as scarce as ever, and whilst that obtains pig iron prices are likely to remain firm. Makers are all quoting 132s. 6d. for No. 1, 127s. 6d. for No. 3 G.M.B., 125s. for No. 4 foundry.

Hematite Pig Iron.

The East Coast hematite pig iron trade is also rather quieter. There is, however, very little iron available for prompt sale. Consumers show little disposition to contract for forward business. Small prompt parcels of mixed numbers readily realise 127s. 6d. per ton, but for June–July delivery, makers are prepared to sell mixed numbers at 125s. per ton, or 126s. for No 1 quality.

Iron-making Materials.

With freights a trifle easier best Rubio ore is now on offer at 24s. 6d. per ton c.i.f. Tees, but without attracting buyers. The price of good Durham furnace coke remains at a maximum of 42s. 6d. per ton delivered at the works.

Manufactured Iron and Steel.

Increasing activity is reported in the manufactured iron and steel trade, and manufacturers are having to cope with a brisk inquiry. There are plenty of orders circulating, and in view of the higher costs of production, prices tend to become firmer. Quotations are not appreciably altered, but manufacturers are holding out for extras for special work, and special prices are being asked where heavy transport charges are involved.

A Big Steel Merger.

A big amalgamation scheme was recently decided

upon, whereby five iron and steel manufacturing concerns on Tees-side come under the control of Dorman, Long and Co., Limited. The firms involved in the transaction are Dorman, Long and Co., Limited, Bell Brothers, Limited, the North-Eastern Steel Company, Sir B. Samuelson and Co., Limited, and the Carlton Iron Company, Limited. The capital of the concerns will be £11,950,000, and the undertakings will enable Dorman, Long's to possess all the raw materials they need, and allow for further extensions to their business.

The Coal Trade.

Although business in the Northern coal trade rules on quieter lines, the market retains all its recent strength and assurance. At the moment prompt business is seriously retarded by the congestion at the docks and staiths, and so far efforts have failed to effect any improvement. It is interesting to record that the London and North-Eastern Railway Company now intends to proceed with the work of completing West Dunston staiths. This is the outcome of representations made by local coal exporters, colliery owners, shipowners, and others interested in shipping above Newcastle bridges, for better facilities for the great increase in the coal export trade, and to relieve the congestion at the old Dunston staiths. When the engineering work at West Dunston is finished, then the question of opening the staiths will be reviewed again. There are strong hopes that trade will then be sufficiently brisk to justify the opening out of the staiths, but if, on the other hand, there is only sufficient coal offered to keep Dunston and West Dunston working two shifts, the railway company has pointed out that no advantage would be gained, since by continuing to work three shifts at Dunston, it would be able to ship as much coal as by working two shifts at both places. The collieries report very full turns, and as the output not already contracted for is limited, the turnover for this side of June is not very large. On the surface the outlook seems quite bright and hopeful, but there are factors in the situation which call for caution and consideration before entering into anything approaching heavy commitments. Some of the larger operators are still of the opinion that the present position is unstable and fictitious, and will probably be modified in the matter of prices very considerably before long. This, however, is merely a hazard, which may or may not be justified. In the meantime prices are very firmly indicated for all classes of coal for any early shipment, though buyers are chary of committing themselves ahead at present high prices. There is said to be a renewal of feelers for Germany and Scandinavia for supplies for July to December, and also for July to March next year. Though not as yet resulting in actual business, this gives promise of forward business later on. The coke market appears to be easier for foundry coke, but a number of inquiries are in hand for Sweden, France, and Italy, which will probably effect some recovery in the tone of the market very soon. Gas coke is very quiet, and prices are weaker.

Graving Docks Scheme.

It is understood that Swan, Hunter and Wigham Richardson, Limited, do not propose to construct a new shipyard on the river Tees, but to construct two large graving docks, provided that costs are not too high. The scheme will be delayed if prices are prohibitive. Land has been purchased in connection with the scheme.

Cleveland Miners' New Hours.

The Cleveland ironstone miners began operations under the new eight-hour arrangement this week, and the first fruits of the concession in the way of increased employment are already being reaped. Bolckow, Vaughan and Co.'s North Skelton mines, after being closed down for over two years, have been partially reopened. The workings of Bell Brothers' Lumpsey mine are being prepared for the re-entry of the miners, and it is hoped that in the course of the next few weeks the extraction of ironstone will have been commenced. It is also expected that other mines will be restarted in the near future. The miners' representatives are now engaged in preparing a new scale of wage rates, to be submitted to the employer at an early date. The object of the new scale is to secure a uniform rate of pay throughout the district. A new sliding scale is also engaging attention.

SCOTLAND.

(From our own Correspondent.)

Reduced Activities.

THE gradual change in conditions resulting from increased costs of production is becoming more and more apparent. Contracts which were procurable a few months ago are now out of the question so far as local producers are concerned, in view of the high prices of raw materials and fuel. Thus, the situation is again rapidly approaching the stage when inquiries were plentiful enough, but firm orders few and far between. Therefore, though a fair amount of employment may be guaranteed for some little time ahead, the outlook is unfavourable. One shipbuilding concern on the Clyde has had to close down, owing to the impossibility of obtaining steel ordered from Germany in connection with work on hand. Tenders based on the price charged for home material of a similar character would be altogether excessive, and would place local shipyards at a distinct disadvantage, unless perhaps in cases where the very best of materials were specified. At the moment, buyers everywhere are looking with disfavour at the upward trend of prices, and there is a growing determination to withhold orders until more normal conditions are established. The position in the Ruhr was a spur to local industries so long as prices were kept at marketable levels, but the effect threatens to be all in the opposite direction now. The high cost of fuel and heavier freightage are proving tremendous barriers to expansion in trade, and an early adjustment in these charges is most imperative. The huge quantities of coal sold for export have left a dangerous shortage, with a consequent enhancing of prices for home consumption and an addition to the price of material production. Add to that the cost of inland transit compared with shipping charges for imported material, and the reason for the present shortage of new business and activities in practically all branches of trade is comparatively plain.

Smaller Demand for Pig Iron.

While there are apparently as many inquiries in the pig iron market, the amount of actual business is diminishing. Hematite is now in better supply, but the price is upheld, though the demand is slackening, both at home and abroad. The same applies to foundry qualities. Only in the case of odd lots is the price occasionally somewhat easier.

Finished Steel and Iron.

Steel makers are experiencing a quieter demand all round, due almost entirely to the rise in prices. This applies to almost all classes of material, even sheets, which have maintained a fair measure of activity, while other descriptions were doing next to nothing. The works in operation have still a good tonnage to overtake, especially in sectional steel, but further developments in the industry would appear to be arrested meantime at least. Prices in some instances continue to show an upward tendency. Bar iron makers also report a slackening, more especially in the export department. The present price of £12 10s. per ton for Crown quality iron bars indicates an advance of 40s. since the beginning of this year. Re-rolled steel bars have a good market. In scrap material there is a continued shortage of heavy smelting descriptions, and also wrought iron, and supplies are not always obtainable, despite the prices being offered.

Coal.

Nothing has occurred to alter the conditions dominating the coal trade. The majority of the collieries are sold up to the middle of next month at least, and current business is therefore limited to any odd lots which may come on the market. The congestion at the East of Scotland loading stations continues to present a serious problem. Many loaded wagons are held up at the colliery sidings, thereby causing a shortage of empties and a fair amount of broken time at the collieries. Forward inquiries for export are numerous enough, but prices are too firmly held to entice buyers. Shipments were heavy during the past week, and amounted to 394,631 tons, against 386,579 tons in the preceding week and 216,649 tons in the same week last year. The home market also is adversely affected by the scarcity of fuel and the rise in prices, and only house coal shows any signs of activity. It is said that municipal concerns are delaying contracts until some idea of the future trend of prices is forthcoming.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Position.

GENERALLY speaking, there has been practically no change in the position so far as the steam coal trade is concerned during the past week. Prices all round have kept quite firm, as coals are as scarce as ever. One thing is very evident, and that is that it will take some weeks to recover from the stoppage which took place in the Rhondda district, and, recognising the futility of endeavouring to meet their contractual engagements for this month's quantity, some of the collieries have notified their contractors that their quantities are cut down. Collieries have sufficient tonnage in dock to keep them very busy for a week or two, even supposing that no more steamers come along, and so far as new business is concerned, many salesmen cannot entertain further orders for a month or more. A considerable amount of delay has been incurred recently in getting away cargoes, and this has caused a good deal of anxiety to exporters in view of the fact that some of them at least have been threatened that if the shipments are not effected by certain dates, according to their sales, their buyers abroad will cancel the cargoes. Exporters are practically helpless in the matter, and it has been a regular experience to find forty or fifty steamers kept out in the Barry Roads and refused admittance to port on account of the congestion prevailing in the docks. Shipowners also have had reason to complain on this score, which is not surprising, seeing that it has taken them a month to get loaded and sailed. Many steamers have been waiting a fortnight before even getting a loading berth.

Three-shift Question.

Interesting developments have taken place since I wrote a week ago. After hearing the evidence for the employers, the court of inquiry decided to adjourn until Thursday of this week to enable the representatives of the workmen to prepare their case, but last Thursday negotiations took place in order to see if a settlement could not be come to, and the result was that a provisional agreement was come to which the parties pledged themselves to recommend to their respective sides for acceptance. Following on this, mass meetings of the trimmers and tippers at the various ports were held on Sunday to consider the terms which had been arranged, and it was thought that the three-shift question was as good as settled, but such was not the case, as while the Port Talbot men agreed to accept them and the Swansea men left the matter in the hands of their representatives, the meeting of the Cardiff, Penarth and Barry men rejected the terms by a large majority. The provisional agreement provided that a third shift should be worked to the extent required by the employers in consultation with the workmen, and that up to May 22nd, when the agreement for a third shift working on the North-East Coast expires, the employers should pay an extra 33⅓ per cent. over the existing earnings in respect of such third shift, but unless otherwise agreed in the interval, no extra remuneration beyond that date. It was also agreed that proposals for the reduction of the existing tariffs should not be proceeded with, but that in the case of the trimmers the present wages should be stabilised until June, 1924, while as regards the tippers, who are employed by the railway company, application would be made to the Railway Wages Board not to reduce the earnings of tippers up to that date. In view of the decisions at the mass meetings, the men's delegates met on Monday to discuss the situation, and on Tuesday their representatives met the representatives of the employers and asked the latter for certain concessions, more especially as regards the securing of some guarantee respecting the maintenance of the minimum wage rates after the agreement applicable to the North-East Coast expires. It was promised that the matter should be laid before the National Trimming Board on the Wednesday, after which the whole question would be submitted to Mr. J. A. Compston, the chairman of the court of inquiry, on the Thursday, who would decide whether the court of inquiry would resume its proceedings or a further attempt be made to arrive at a settlement through negotiations between the two parties.

Trade with Canada.

The announcement is made that the Canadian Government Merchant Marine, Limited, will largely extend the steamship services at present maintained by it between Canada and South Wales, with the opening of the navigation of the river St. Lawrence this month. This service was started in June, 1921, and has been maintained since then with very good results in the development of direct trade. The new developments provide for regular fortnightly services from both the ports of Cardiff and Swansea to Quebec and Montreal. Large steamers of 8100 tons are to be placed on the route. Some of them are equipped with cold storage space, and this facility will be provided on all of them if the occasion warrants it.

Cardiff Shipowners.

A list issued by the secretary of the Cardiff District of the Shipping Federation shows that there are altogether 102 shipping firms entered as members, and that they own 361 vessels, of 961,980 tons gross, representing a carrying capacity of nearly 2,000,000 tons.

New Industry for Newport.

A new industry has been established at Newport, this being the manufacture of colliery conveyor plant. The Finlay Conveyor Company, Limited, has taken over the Brithdir Yard, near the western side of the transporter bridge, and it will commence operations as soon as the premises are equipped.

Current Business.

Collieries have so little coal to dispose of that business for loading during the remainder of this month and the early part of May is confined to small parcels, for which they can secure very good prices Nominally, best Admiralty large coals are from 42s. 6d. to 45s., and second qualities command about 42s. 6d., but buyers abroad are not showing much, if any, inclination to effect fresh purchases at these figures. Any sales that are being made are being done through exporters who hold superior steam coals on contract, which enables them to dispose of their holdings at several shillings less and still make a good profit. Small coals are even scarcer than large coals, and are quoted up to 35s., but patent fuel is now lower, doubtless as the result of the lower cost of pitch imported from Pensacola. The price is now from 40s. to 45s. Anthracite coals are gradually improving in demand and hardening in price. This is especially the case in sized qualities.

Tin-plate Market.

The tin-plate market is slightly easier, business being less active. Works are, however, well booked up for the next two or three months.

LAUNCHES AND TRIAL TRIPS.

GLENLOCHIE, single-screw steamer; built by Swan, Hunter and Wigham Richardson, Limited, to the order of the Canadian Lakes and Canals; dimensions, 250ft. by 42ft. 6in. by 20ft. 6in. Engines, triple-expansion, pressure 180 lb.; constructed by the builders; launch, April 14th.

NISBET GRAMMER, single-screw steamer; built by Cammell Laird and Co., Limited, to the order of the Eastern Steamship Company, Limited; dimensions, 253ft. by 43ft. 3in. by 20ft.; to carry grain. Engines, surface condensing inverted triple-expansion, 16in., 27in., and 44in. by 33in. stroke, pressure 180 lb.; constructed by the builders; launch, April 14th.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

WE understand that Sir Richard T. Glazebrook, K.C.B., F.R.S., has been elected an honorary member of the Institution of Civil Engineers.

MR. H. S. ASPINALL, who recently resigned his appointment as sales manager and director of the Keighley Gas and Oil Engine Company, Limited, has been appointed general sales manager to Vickers-Petters, Limited, of Ipswich Works, Ipswich. His headquarters will be at Ipswich.

FARADAY HOUSE ENTRANCE SCHOLARSHIPS.—As a result of the entrance scholarship examination held at Faraday House Electrical Engineering College on April 10th, 11th and 12th, the following awards have been made:—To B. K. Watts (Aldenham School, Elstree), the "Faraday" Scholarship of fifty guineas per annum, tenable for two years in college and one year in works; to J. B. Browning (St. George's School, Harpenden), the "Maxwell" Scholarship of fifty guineas per annum, tenable for one year in college and one year in works; to S. Anderson (Bedford School), an Exhibition of thirty guineas per annum, tenable for two years; to L. B. Law (the Grammar School, Shaftesbury), an Exhibition of twenty guineas per annum, tenable for two years; and to J. Chavooshian (private study), an Entrance Prize of twenty guineas.

Current Prices for Metals and Fuels.

IRON ORE.

N.W Coast—	
Native	28/-
(1) Spanish	24/-
(1) N. African	24/-
N.E. Coast—	
Native	—
Foreign (c.i.f.)	24/6

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) Scotland—		
Hematite	6 7 6	—
No. 1 Foundry	6 2 6	—
No. 3 Foundry	5 17 6	—
N.E. Coast—		
Hematite Mixed Nos.	6 7 6	6 7 6
No. 1	6 8 6	6 8 6
Cleveland—		
No. 1	6 12 6	6 12 6
Siliceous Iron	6 12 6	6 12 6
No. 3 G.M.B.	6 7 6	6 7 6
No. 4 Foundry	6 5 0	6 5 0
No. 4 Forge	6 0 0	6 0 0
Mottled	—	—
White	—	—
Midlands—		
(3) Staffs.—		
All-mine (Cold Blast)	13 0 0	—
North Staffs. Forge *	—	—
,, ,, Foundry	5 12 6 to 5 15 0	
(3) Northampton—		
Foundry No. 3 *	—	—
,, Forge *	—	—
(3) Derbyshire—		
No. 3 Foundry	5 7 6	—
Forge	5 0 0 to 5 5 0	
(3) Lincolnshire—		
Basic (zone offering)	6 0 0 to 6 10 0	
Foundry	5 10 0	—
Forge	5 5 0	—
(4) N.W. Coast—		
N. Lancs. and Cum.		
Hematite Mixed Nos.	7 2 6	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	12 10 0	—
Best ,,	—	—
N.E. Coast—		
Crown Bars	12 0 0	—
Tees	10 0 0	—
Lancs.—		
Crown Bars	12 15 0	—
Second Quality Bars	12 0 0	—
Hoops	15 0 0	14 15 0
S. Yorks.—		
Crown Bars	12 10 0	—
Best ,,	13 10 0	—
Hoops	15 10 0	—
Midlands—		
Crown Bars	12 10 0	—
Marked Bars (Staffs.)	14 10 0	—
Nut and Bolt Bars	11 10 0 to 11 15 0	
Gas Tube Strip	13 5 0 to 13 10 0	

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) Scotland—		
Boiler Plates	13 0 0	—
Ship Plates ⅜in. and up	10 5 0	-
Sections	10 0 0	—
Steel Sheets, ⅛ in. to ½ in.	12 10 0	—
Sheets (Gal. Cor. 24 B.G.)	—	20 0 0

STEEL (continued)

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	10 10 0	—
Angles	10 0 0	—
Boiler Plates	14 0 0	—
Joists	10 0 0	—
Heavy Rails	10 10 0	—
Fish-plates	14 10 0	—
Channels	9 5 0	—
Hard Billets	10 15 0	—
Soft Billets	10 10 0	—
N.W. Coast—		
Barrow—		
Heavy Rails	10 5 0	—
Light ,,	13 0 0	—
Billets	11 0 0	—
Manchester—		
Bars (Round)	12 0 0	—
,, (others)	11 0 0 to 11 5 0	
Hoops (Best)	15 5 0	15 0 0
,, (Soft Steel)	13 15 0	13 10 0
Plates	11 0 0 to 11 10 0	
,, (Lancs. Boiler)	13 10 0	—
Sheffield—		
Siemens Acid Billets	13 0 0	—
Bessemer Billets	13 10 0	—
Hard Basic	10 15 0	—
Intermediate Basic	10 10 0	—
Soft Basic	9 10 0	—
Hoops	12 15 0 to 13 5 0	
Soft Wire Rods	13 0 0 to 13 10 0	
Midlands—		
Small Rolled Bars	12 0 0	—
Billets and Sheet-bars	9 15 0 to 10 0 0	
Gas Tube Strip	12 0 0	—
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets (f.o.b. L'pool)	19 10 0 to 19 15 0	
Angles	10 10 0	—
Joists	10 10 0	—
Tees	11 10 0	—
Bridge and Tank Plates	10 15 0 to 11 0 0	

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14	25/- to 25,6
Block Tin (cash)	211 15 0
,, (three months)	212 0 0
Copper (cash)	73 5 0
,, (three months)	74 2 6
Spanish Lead (cash)	27 0 0
,, (three months)	27 2 6
Spelter (cash)	34 12 6
,, (three months)	34 12 6
Manchester—	
Copper, Best Selected Ingots	78 0 0
,, Electrolytic	81 0 0
,, Strong Sheets	106 0 0
,, Loco Tubes	0 1 2½
Brass Loco Tubes	0 1 1
,, Condenser	0 1 2½
Lead, English	28 0 0
,, Foreign	27 0 0

FERRO ALLOYS.

(All prices now nominal.)

	Per Ton.	Per Unit
Tungsten Metal Powder	1/11 per lb.	
Ferro Tungsten	1/5 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23	10/6
,, 6 p.c. to 8 p.c. ,,	£21 0 0	8/-
,, 8 p.c. to 10 p.c. ,,	£20 0 0	8/-
,, Specially Refined		
,, Max. 2 p.c. carbon	£52 0 0	20/-
,, ,, 1 p.c. ,,	£62 0 0	22/6
,, ,, 0·75 p.c. carbon	£72 0 0	25/-
,, carbon free	1,6 per b.	
Metallic Chromium	4/6 per lb.	
Ferro Manganese (per ton)	£16 for home.	
,, Silicon, 45 p.c. to 50 p.c.	£13 0 0 scale unit	5/- per
,, ,, 75 p.c.	£21 0 0 scale unit	6/- per
,, Vanadium	17/- per lb.	
,, Molybdenum	9/6 per lb.	
,, Titanium (carbon free)	1/1 per lb.	
Nickel (per ton)	£130	
Cobalt	12/- per lb.	
Aluminium (per ton)	£82 to £100 (British Official.)	

FUELS.

SCOTLAND.

	Export.
Lanarkshire—	
(f.o.b. Glasgow)—Steam	27/-
,, ,, Ell	29/6
,, ,, Splint	31/- to 34/-
,, ,, Trebles	30/6
,, ,, Doubles	30/-
,, ,, Singles	29/6
Ayrshire—	
(f.o.b. Ports)—Steam	27/-
,, ,, Splint	31/-
,, ,, Trebles	30,6
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	27,6 to 32/-
Screened Navigation	35/-
Trebles	31/-
Doubles	30/-
Singles	30/-
Lothians—	
(f.o.b. Leith)—Best Steam	30/-
Secondary Steam	28/-
Trebles	31/-
Doubles	30/6
Singles	30/-

ENGLAND.

(8) N.W. Coast—	
Steams	31,6
Household	46/6 to 57/6
Coke	48/-
Northumberland—	
Best Steams	34/6 to 35/-
Second Steams	31,6 to 33,6
Steam Smalls	23/- to 25/-
Unscreened	20/6
Household	25/- to 28/-
Durham—	
Best Gas	33/- to 35/-
Second	32,6
Household	25/- to 28/-
Foundry Coke	70/- to 75/-

	Inland.
Sheffield—	
Best Hand-picked Branch	32/6 to 34/6 —
Barnsley Best Silkstone	28/- to 30/- —
Derbyshire Best Brights	25/6 to 27/6 —
,, ,, House	23/- to 24/6 —
,, ,, Large Nuts	20/6 to 22/6 —
,, ,, Small ,,	18/- to 21/- —
Yorkshire Hards	22/- to 24/- —
Derbyshire ,,	21/- to 24/- —
Rough Slacks	12/- to 14/- —
Nutty ,,	10/6 to 12,6 —
Smalls	7/- to 9/- —
Blast Furnace Coke (Inland)	24/- to 27/-
,, ,, ,, (Export)	44/- to 47/-

(9) SOUTH WALES.

Cardiff— Steam Coals:	
Best Smokeless Large	42.6 to 43/-
Second ,, ,,	40/- to 42,6
Best Dry Large	40/- to 42/6
Ordinary Dry Large	37/6 to 40/-
Best Black Vein Large	40/- to 42/6
Western Valley ,,	37/6 to 40/-
Best Eastern Valley Large	37/6 to 40/-
Ordinary ,, ,,	33/- to 35/-
Best Steam Smalls	33/- to 35/-
Ordinary ,,	25/- to 30/-
Washed Nuts	30/- to 35/-
No. 3 Rhondda Large	40/- to 42,6
,, ,, Smalls	30/- to 32,6
No. 2 ,, Large	32/6 to 35/-
,, ,, Through	30/- to 32/6
,, ,, Smalls	25/- to 27,6
Coke (export)	70/- to 80/-
Patent Fuel	40/- to 45/-
Pitwood (ex ship)	30/- to 31/-
Swansea— Anthracite Coals:	
Best Big Vein Large	45/- to 47/6
Seconds	42/6 to 45/-
Red Vein	30/- to 32/6
Machine-made Cobbles	52/6 to 55/-
Nuts	52/6 to 55/-
Beans	47/6 to 50/-
Peas	24/- to 26/-
Breaker Duff	12/- to 13/-
Rubbly Culm	17/- to 17/6
Steam Coals:	
Large	29/- to 31/-
Seconds	26/- to 27/-
Smalls	19/- to 21/-
Cargo Through	23/- to 25/-

(1) Delivered. (2) Net Makers' works. (3) At furnaces. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—F.O.B. Glasgow.

(8) Except where otherwise indicated coals are per ton at pit for inland and f.o.b. for export and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b.

* Quotations extremely high and nominal.

French Engineering Notes.

(From our Correspondent in Paris.)

Foreign Contracts.

THE leading engineering concerns have for a long while past been negotiating, in association with certain financial groups, for the carrying out of railway, bridge and other undertakings in countries devastated by the war and in States where efficient railway systems are necessary for their commercial and industrial development. Some time ago it was announced that arrangements had been made to give financial aid to Poland for the putting in hand of reconstruction works, and the French Government recently granted a loan to that country to be employed for the payment of contracts being executed by French firms. Now it is stated that similar financial assistance is being accorded to another country which is placing orders for railway, bridge and other work to the value of 100,000,000f. The outlook for the constructive engineering trades is therefore satisfactory, particularly in view of the large amount of work that will be done as soon as the financial situation is stabilised by a settlement of the reparation problem. The only thing, apart from the financial stringency, that stands in the way of a general activity is the scarcity and dearness of raw material, and it is hoped that this will be alleviated by the increasing quantities of coke arriving from the Ruhr. Unfortunately, while the supplies have helped to improve the situation there is a general feeling that there will be considerable difficulty in procuring further quantities as soon as the French have cleared the Ruhr of its stocks of coke.

Angora Concessions.

In 1914 the French Government made an important loan to the Ottoman Government in return for certain concessions, which included the building of railways in Anatolia and the construction of the port of Samsoun. The concessions were confirmed by the Treaty of Angora, and it hardly seemed possible that the National Assembly would be able to repudiate them, as it did other privileges granted by the former Government in Constantinople. Nevertheless, the ratification by the National Assembly of the Chester project on behalf of the Ottoman American Development Company appears to have seriously imperilled the French concessions, since the undertakings which were to have been carried out with French capital are specifically included in the general development work conceded to the American groups. The apparent lack of good faith on the part of the Turks has aroused strong feeling in this country, where the loss of future trade opportunities in Anatolia is a serious matter for engineering concerns, which were looking to that market to provide important contracts for railway, bridge and other material. Nevertheless, it is evident that the French are quite unable to find the capital necessary for the undertakings, and apparently the Turks argue that the United States is the only country at present capable of supplying the funds and executing the work without imposing charges upon the Turkish Government. The French, however, will not accept any repudiation of their concessions, and a vigorous protest has been sent to the Angora National Assembly. It is clear that the matter will not be allowed to remain where it is, and at the forthcoming Lausanne Conference the whole question will be discussed, and it is hoped that an arrangement giving satisfaction to all concerned will then be come to.

International Transit.

During the past few years active propaganda has been carried out in favour of accelerating traffic from Switzerland and Central Europe to the Atlantic ports, the idea being to divert to French ports the traffic that at present goes to Hamburg and Genoa. From time to time Swiss delegates have been invited to visit Lorient, Bordeaux, Nantes, St. Nazaire and other ports where they were able to see that the equipment is sufficient to deal with any traffic that may pass through them. To take full advantage of the facilities, however, the ports must be put into more direct communication with Switzerland, and of the various projects that have been put forward the only one that has found favour with the Government, because it entails the least expense, is the linking up of the railway systems between Lyons and Nantes. A much shorter route would be the Est line from Lons-le-Saunier on condition of that line being connected up direct with Geneva by a tunnel through the Faucille, instead of being obliged to make a long and difficult detour by Pontarlier. The project of driving a tunnel through the Faucille is a very old one, and appeared likely before the war to have a chance of being carried out, but since the Government decided upon an improvement of the Lyons to Nantes route the Faucille proposal has been officially abandoned. The idea, however, is still being agitated by the various interests concerned, notably by the Chambers of Commerce of Nantes and St. Nazaire, which argue that the only way of diverting traffic to the Atlantic ports is to employ the shortest and easiest route by the construction of the Faucille tunnel, and efforts are being made to merge the Faucille enterprise into a general plan which will include the tunnelling of Mont Blanc. The competition of Hamburg and Genoa is so keen that traffic can only be diverted over the French lines on condition of their offering an economy in time and money, and it is believed that this development of international traffic would have the effect of bringing down freights for inland transport.

Machinery Trade.

Notwithstanding the difficulties offered by the exchange rate fluctuations there has been an improvement in the foreign trade in machinery, and during the first two months of the year the quantity of steam and other prime movers imported was 29,928 tons, as compared with 20,057 tons in the first two months of 1921. The imports of boilers declined from 3325 tons to 1832 tons, and machine parts from 4506 tons to 4415 tons, although in the latter case there was a considerable increase in value. The exports of steam engines and other prime movers amounted to 11,020 tons, as against 7737 tons; boilers, 566 tons, as compared with 608 tons, and machine parts, 5850 tons, as against 4346 tons.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

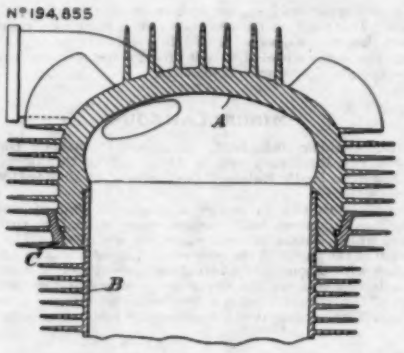
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

194,855. January 19th, 1922.—CYLINDER HEADS, D. Napier and Son, Limited, and G. S. Wilkinson, 211, Acton-vale, London, W. 3.

This invention aims at the maintenance of a tight joint between the cylinder and cylinder head of air-cooled engines, in which the two parts have different coefficients of expansion. The head A of an aluminium alloy is screwed on to the steel

N°194,855

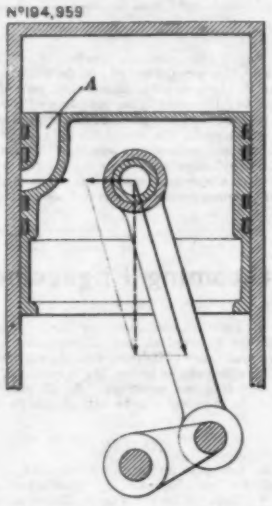


cylinder B, and a steel ring C is screwed on to a conical thread on the outside of the head. The part of the head which makes the joint is thus confined between two pieces having the same coefficient of expansion, and its expansion is controlled, with the result that a tight joint is maintained.—*March 22nd*, 1923.

194,959. April 19th, 1922.—PISTONS, A. Renaudin, 17, Rue de la Republique, Lyons, France.

The inventor suggests that it is possible to prevent internal combustion engines from "knocking" by providing the passage A, between the upper face of the piston and its side, directly

N°194,959



opposite to the gudgeon pin. The reaction of the explosion pressure against the cylinder wall at the lower opening of the passage is intended to keep the piston tight against the opposite wall, and thus eliminate the knocking.—*March 27th*, 1923.

BATTERIES AND ACCUMULATORS.

194,924. March 7th, 1922.—IMPROVEMENTS IN AND RELATING TO GALVANIC BATTERIES, Fuller's United Electric Works, Limited, of Woodland Works, Grove-road, Chadwell Heath, Essex, and Leonard Fuller, of Woodland Works, Grove-road, Chadwell Heath, Essex.

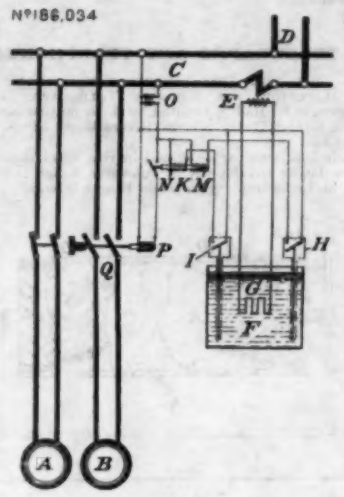
This invention refers particularly to the dry battery, in which paste or jelly is used as the electrolyte, and is inserted in a zinc receptacle also containing the "dolly" or positive element surrounded by the depolarising material. The usual zinc container containing the "dolly" is employed. The space between the zinc container and the "dolly" is filled with jelly or paste electrolyte. The top surface of the electrolyte is then covered with a layer of cement or plaster which has added to it a proportion of active salts or electrolyte. This plaster layer may, in turn, be covered with a layer of wax or suitable sealing compound for preference impervious to moisture. The cell may then be filled in with sawdust or other material to provide a trap for any gases or moisture driven from the cell. The cell may then be sealed in the usual way.—*March 22nd*, 1923.

SWITCHGEAR.

186,034. March 22nd, 1923.—IMPROVED APPARATUS FOR EFFECTING THE AUTOMATIC CONNECTING-IN AND DISCONNECTING OF ELECTRICAL MACHINE UNITS, Aktiengesellschaft Brown, Boveri & Cie., of Baden, Switzerland.

This invention relates to the automatic switching-in and switching-out of machine units by means of thermal relays. The two machine units A and B, of which only A is at first assumed to be connected-in, feed the network D through the bus-bars C. The network current is transmitted through a transformer E to a heating resistance G situated in the oil tank F. In the same oil tank there are also two thermal relays H and I, which become energised at different temperatures. First, the relay H closes its contact at a predetermined temperature, and thereby brings the holding coil M of the relay K into circuit. This coil is, however, not strong enough to close the switch of relay K. Only when at a predetermined greater load and consequent higher temperature of the oil bath F is reached

N°186,034



does the temperature relay I come into operation. The switching-in coil N then also receives the voltage of the auxiliary source O, and the switch of the relay K closes. The switch Q is closed by the switching-in magnet P, and thereby the second machine B is connected-in. The specification also describes the process of switching-out the machines.—*March 22nd*, 1923.

MOTOR CARS AND ROAD TRAFFIC.

194,643. December 20th, 1922.—SPRING SUSPENSION, J. H. Stott, Glen May, Osmaston Park-road, Derby.

This specification is concerned with a system of springing in which the spring is automatically made stiffer as its deflection is increased by advancing load. The spring is of the cantilever type, in which the *encastrément* fitting A rotates about a pivot B. Two stops C C, fixed to the frame of the vehicle, engage with

N° 194,643

Fig. 1.

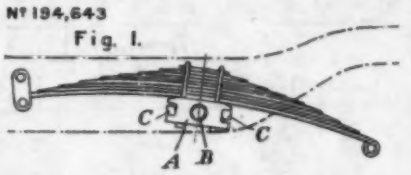


Fig. 2.

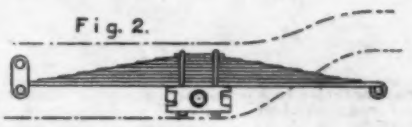
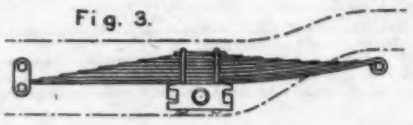


Fig. 3.



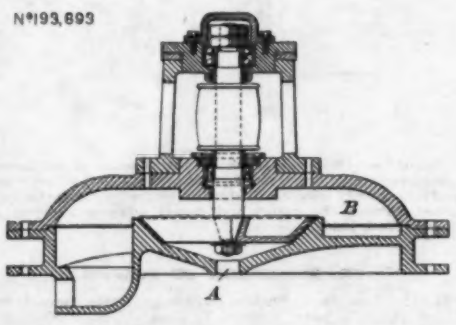
horns on the fitting A. In the unloaded condition—as shown in Fig. 1—the stops take no load. When half load is applied the stops just touch the horns of the fitting—as shown in Fig. 2. If the load is increased still more the left-hand end of the spring does not deflect any more, as the stops limit the rotation of the fitting A, and the stiffness of the spring is doubled. The specification contains a mathematical investigation of the action of the spring and describes several modifications.—*March 15th* 1923.

CRUSHING AND GRINDING.

193,693. March 8th, 1922.—FINE GRINDING, F. J. E. China, Downhouse, Esher, Surrey, and Burt, Boulton and Haywood, Limited, Salisbury House, London-wall, London, E.C. 2.

This invention relates to the fine grinding of substances while they are suspended in a liquid medium. The suspension is spread out into a thin film, the disintegration being brought about by shearing or rupturing the film by imparting to the co-

N°193,693



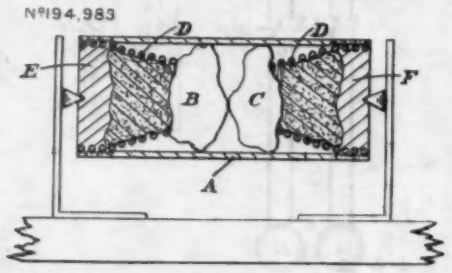
acting surfaces of the mill, which confine or enclose the film a relative sliding movement at a very high speed, which may be as much as 20,000ft. to 30,000ft. per minute, the clearance width between the two surfaces being made very small—for instance, from a few hundredths of an inch down to a few thousandths of

an inch. The suspension is fed under pressure into the mill at A. Pressure and centrifugal force cause the liquid to flow through the capillary space to the surrounding jacket B. The frictional forces produced by the high speed of rotation and at work in the film between the two opposing surfaces in some way cause the solid particles in suspension in the liquid to be torn apart. The mechanical features of the mill need little description.—*March 1st*, 1923.

TELEGRAPHS AND TELEPHONES.

194,983. May 26th, 1922.—Improvements in and relating to Detectors for Wireless Telegraphy and Telephony, B.M. Radio, Limited, of 5, Regent-square, London, W.C. 1, and Henry Rivers Rivers-More, of 28, Park-hill, Croydon.

The wireless detector described in this specification consists of an insulating envelope A of vulcanite, which is screwed internally and contains two crystals B and C, which are held in

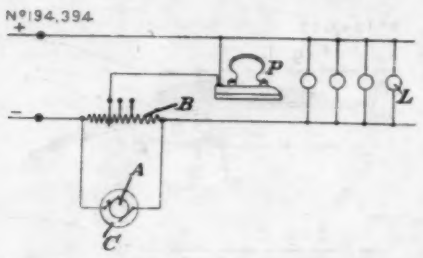


contact with one another by tapered springs D, these springs being screwed into the envelope at each end. Soft metal seals E and F retain the crystals and springs in a fixed position.—*March 22nd*, 1923.

MEASURING AND TESTING INSTRUMENTS.

194,394. December 9th, 1921.—Improvements in or relating to Electricity Meters, William Morris Mordey, of 82, Victoria-street, Westminster, and the Electrical Apparatus Company, Limited, of Vauxhall Works, South Lambeth-road.

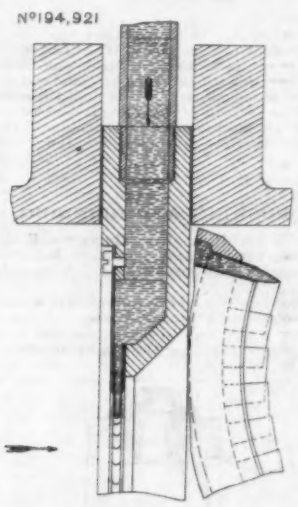
The specification describes an electricity meter capable of measuring and recording simultaneously or successively the amount of energy supplied for either or both lighting and power. In the drawing A is the armature of the rotor, which is connected



in shunt to a small fixed resistance B, called the series resistance The stator C may be a permanent magnet. With the lighting load L and power load P connected as shown, the meter will register the full lighting units and one-third of the units power units, and the meter will therefore give the total amount to be paid by the consumer.—*March 9th*, 1923.

194,921. March 3rd, 1922.—Orifices, J. L. Hodgson, Eggington House, near Leighton Buzzard.

In meters which depend for their accuracy on the size of an orifice through which the fluid flows, it is, of course, imperative that the orifice should not be choked with any deposit. The

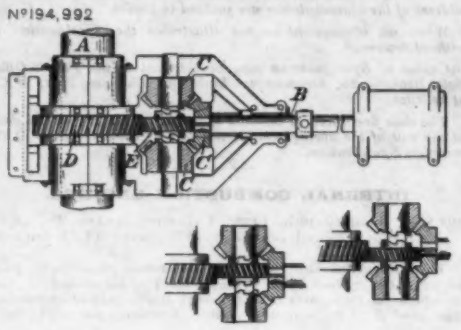


inventor therefore forms the orifice with a series of overlapping plates, arranged much as roofing tiles, as shown in the illustration, and occasionally injects a fluid which escapes through the interstices between the plates and scours away any deposit.—*March 22nd*, 1923.

TRANSMISSION OF POWER.

194,992. June 22nd, 1922.—Continuous Drive from Intermittent Rotary Motion, T. Reid and N. T. Finlayson, Dundas, Ontario, and Pitt Railway Equipments, Limited, 17, St. John-street, Montreal, Quebec.

This gear has been invented for driving such machines as the dynamos of train lighting sets in one direction regardless of the direction of rotation of the primary mover. Thus, for instance, A is the axle of a railway coach and B the spindle of the lighting dynamo. A may rotate in either direction, but B must always revolve one way. The two shafts are connected through the mitre wheels C C C and the herringbone gears D and E. The gear wheel E is free to slide on its shaft, and is provided with

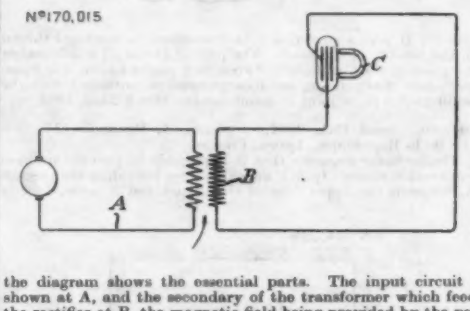


clutch teeth that may engage with either of the adjacent mitre wheels. The reaction between the two herringbone gears will be such that the gear wheel E will slide endways on its shaft and engage the mitre wheel that will produce the required rotation of the spindle B.—*March 22nd*, 1923.

MISCELLANEOUS.

170,015. October 10th, 1921.—Electric Discharge Devices for the Rectification of Alternating Currents, The American Radio Research Corporation, of Medford, Massachusetts.

According to this invention a magnetic field of constant strength is impressed on a gaseous space separating two electrodes, which consist of two concentric cylinders. The combination of the gap with the impressed magnetic field in a circuit supplied with a source of alternating current causes current to be conducted between the electrodes in only one direction, and to cut off the current when it is flowing in the opposite direction. The specification describes a considerable amount of detail, but



the diagram shows the essential parts. The input circuit is shown at A, and the secondary of the transformer which feeds the rectifier at B, the magnetic field being provided by the permanent magnet C. This rectifying property of the gap is believed to be due to the fact that the path of electrons leaving the outer cylinder is lengthened by the magnetic field sufficiently to cause collisions and initiate ionisation, whereas the paths of electrons leaving the inner cylinder are either unaffected by the magnetic field or affected in a manner to shorten the normal path so that ionisation and gaseous conduction is not set up.—*February 12th*, 1923.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the time and place *at which the meeting is to be held should be clearly stated.*

TO-DAY.

Institution of Mechanical Engineers.—Storey's-gate, S.W. 1. Hardness Tests Research: "Static Indentation Tests," by Mr. R. G. C. Batson, and "The Relation between Width of Scratch and Load on Diamond in the Scratch Hardness Test," by Mr. G. A. Hankins. 6 p.m.

Institution of Civil Engineers: Yorkshire Association.—Philosophical Hall, Leeds. Paper, "Boiler Plant Economy," by Mr. W. M. Hebblethwaite. 7.30 p.m.

Institution of Engineering Inspection.—Royal Society of Arts, John-street, Adelphi, W.C. 2. Paper, "The Inspection of Ball Bearings," by Mr. C. H. Richardson. 7.30 p.m.

Junior Institution of Engineers.—39, Victoria-street, S.W. 1. Lecturette, "The Business of Engineering," by Mr. H. L. Munro. 7.30 p.m.

Royal Institution of Great Britain.—Albemarle-street, Piccadilly, W. 1. Discourse, "The Growth of the Telescope," by Mr. W. J. S. Lockyer. 9 p.m.

Royal Society of Arts.—John-street, Adelphi, W.C. 2. Joint meeting of Dominions and Colonies and Indian Sections. "A Review of the Base Metal Industry, with Special Reference to the Resources of the British Empire," by Sir Richard A. S. Redmayne. 4.30 p.m.

West Bromwich Engineering Society.—Technical School, West Bromwich. Paper, "Superheated Steam and Superheaters," by Mr. T. A. Pain. 7.30 p.m.

SATURDAY, APRIL 21st.

Institution of British Foundrymen: Lancashire Branch.—Visit to the Stanton Ironworks, Nottingham. Train leaves Manchester (Central) at 8.55 a.m.

MONDAY, APRIL 23rd.

Institution of Automobile Engineers.—The College, Loughborough. Loughborough Graduates' meeting. Paper, "Engine Testing," by Mr. H. R. Ricardo. 7 p.m.

Institution of Automobile Engineers: Scottish Centre.—Royal Technical College, Glasgow. Paper, "Sleeve Valve Engines," by Mr. E. B. Wood. 7.30 p.m.

Institution of Electrical Engineers.—Savoy-place, Victoria Embankment, W.C. 2. Informal discussion on "Practical Broadcasting," to be opened by Mr. E. H. Shaughnessy. 7 p.m.

Institution of Mechanical Engineers.—Storey's-gate, S.W. 1. Graduates' meeting. "Recent Steam Wagon Progress, and a Suggested Design," by Mr. S. H. C. Warne. 7 p.m.

Royal Society of Arts.—John-street, Adelphi, London, W.C. 2. Cantor Lecture: "Nitrates from Air," by Mr. E. Kilburn Scott, M.I.E.E., A.M. Inst. C.E. (Lecture III.) 8 p.m.

TUESDAY, APRIL 24th.

Illuminating Engineering Society.—Royal Society of Arts, John-street, Adelphi, W.C. 2. Discussion on "Some Problems in the Lighting of Printing Works," opened by Mr. Leon Gaster. 8 p.m.

Institution of Automobile Engineers.—Railway Hotel, Coventry. Paper, "Sleeve Valve Engines," by Mr. E. B. Wood. 7.30 p.m.

Institution of Civil Engineers.—Great George-street, S.W. 1. Annual general meeting of corporate members only, to receive the report of the Council and to elect Council and auditors for the ensuing year. 6 p.m.

Manchester Geological and Mining Society.—College of Technology, Manchester. Exhibition by cinematograph film of "The Development of an American Mine, from Coal Face to Wagon, with Modern Machinery," by Mr. J. Drummond Paton. 4 p.m.

WEDNESDAY, APRIL 25th.

Institution of Automobile Engineers: North of England Centre.—Education Offices, Salford. Papers, "The Steam Wagon from the Designer's Point of View," by Mr. F. J. Bretherton, and "The Use and Limitations of the Steam Wagon," by Mr. C. C. M. Gosselin. 7.30 p.m.

Institution of Municipal and County Engineers.—National Physical Laboratory, Teddington. South-Eastern District meeting. Meet at Teddington Station, 2.15 p.m.

THURSDAY, APRIL 26th.

Institution of Electrical Engineers.—Savoy-place, Victoria Embankment, W.C. 2. "The Drive of Power Station Auxiliaries," by Messrs. L. Broach and H. Midgley. 6 p.m.

Institution of Locomotive Engineers.—The Engineers' Club, Coventry-street, W. 1. "The Cooling of Locomotives," by Mr. L. P. Parker. 7 p.m.

Royal Institution of Great Britain.—Albemarle-street, Piccadilly, W. 1. Lecture, "Modern Electric Lamps: I., Glowing Solids in Vacuo (Tungsten Lamps)," by Professor J. T. MacGregor Harris. 3 p.m.

FRIDAY, APRIL 27th.

Institute of Metals: Sheffield Local Section.—Mappin Hall of the University, St. George's-square, Sheffield. Annual general meeting. 7.30 p.m.

Institution of Electrical Engineers: Scottish Centre.—The Technical Institute, Dundee. Paper, "The Drive of Power Station Auxiliaries," by Messrs. L. Broach and H. Midgley. 7.30 p.m.

Institution of Mechanical Engineers.—Storey's-gate, S.W. 1. Informal discussion on "The Use of Light Alloys in Place of Iron and Steel," by Mr. A. E. L. Chorlton. 7 p.m.

Institution of Municipal and County Engineers.—Joint meeting of the Eastern and Metropolitan Districts at Boxmoor, Herts.

Institution of Production Engineers.—The Engineers' Club, Coventry-street, W. 1 Paper, "The Efficient Tooling of Automatics," by Mr. L. C. Keen. 7.30 p.m.

Junior Institution of Engineers.—39, Victoria-street, S.W. 1. Lecturette, "Stock Control," by Mr. J. Fearn. 7.30 p.m.

Royal Institution of Great Britain.—Albemarle-street, Piccadilly, W. 1. Discourse, "Measurement of the Heating Value of Gas," by Mr. C. V. Boys. 9 p.m.

WEDNESDAY, MAY 2nd.

Institute of Metals.—Institution of Mechanical Engineers, Storey's-gate, S.W. 1. Thirteenth annual May Lecture on "The Inner Structure of Alloys," by Dr. W. Rosenhain, F.R.S. 8 p.m.

FRIDAY, MAY 4th.

Institution of Civil Engineers.—Great George-street, S.W. 1. Twenty-ninth James Forrest Lecture entitled "The Interdependence of Abstract Science and Engineering," by Sir Richard T. Glazebrook. 6 p.m.

THURSDAY and FRIDAY, MAY 10th and 11th.

Iron and Steel Institute.—Institution of Civil Engineers, Great George-street, S.W. 1. Annual meeting. For programme, see page 401. 10 a.m. each day.

CONTRACTS.

The Underground Company has just placed two further contracts for escalators, viz.:—Foundation Company, Limited, escalators at Moorgate-street, £42,574; J. Cochrane and Sons, escalators at Shepherd's Bush, £21,709. The escalators at Moorgate-street are to be completed in nine months' time, and those at Shepherd's Bush in seven months' time.

The Newport (Mon.) Corporation, having resolved to make further extensions at its electricity works, recently placed orders with the Spearing Boiler Company, Limited, for boilers.

Hollings and Guest, Limited, of Birmingham, have recently received an order for the supply of five hydraulic presses to Messrs. A. T. and F. E. Birkby, of Liversedge, for use in the manufacture of insulating materials.

La Societe des Chantier et Ateliers de St. Nazaire (Pënhoet) has just received an order from the Western Union Telegraph Company to build a cable ship, which will have a length of 213ft. 3in., a beam of 30ft. 1in., and a displacement of 2200 tons. The vessel is to be fitted with two engines of 600 horse-power which, it is calculated, will give her a speed of 11½ knots.

The Powdered Fuel Plant Company, Limited, has received an order for firing with powdered coal by means of its turbo-pulverisers, five Clarke, Chapman "Woodeson" boilers for the owners of the Pelton Collieries, Limited. The boilers are two of 15,000 lb. and three of 8000 lb. per hour evaporation and seven turbo-pulverisers are being installed, two to each of the larger boilers and one to each of the smaller ones. This firm has also recently received orders for three separate unit plants for the firing of one water-tube boiler and two metallurgical furnaces.